THE

ELECTRICAL REVIEW.

VOL. LIV. APRIL 8, 1904. No. 1,376.

ELECTRICAL REVIEW.

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THE

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THE BOARD OF TRADE AND ELECTRIC TRAMWAY MISHAPS.

WHEN the Board of Trade about a year ago required all tramway undertakings in Great Britain to make a monthly return of almost all the ills to which such a business is liable, it began a work which, from the statistical point of view alone, was likely to be of much value; and in a circular letter dated March 21st, addressed to tramway authorities, the Board of Trade admits that "the returns have furnished them with much valuable information."

Hitherto these returns have called for considerable detail, especially with regard to damage caused by jumping trolleys, for which seven sub-heads were supplied; and, when the inventiveness of the compilers was exhausted, they covered any possible omission by a section headed "other classes of accident."

In the first place, reports of this description have a good moral effect. If a thoroughly conscientious manager feels that accidents which perhaps have become from frequent repetition almost part of the daily routine, and seem unavoidable, or things to be suffered, will come under the eye of a mysterious inquisitor sitting in Whitehall, even though they be not things about which his directors or his Committee trouble, he will develop a surprising keenness with regard to the same kind of accident in future; and we venture to predict that the B. of T. could produce some interesting curves with drooping characteristics showing the diminution of any particular class of accident with the lapse of time.

Without an objectionably active use of its inquisitorial powers, the B. of T. has to depend for the general accuracy of such reports on the integrity of the men who are directly responsible for their manufacture, and, in a more significant degree still, to the completeness of the records of reportable accidents. The major accidents, such as trolley wires falling from any cause, or of guard wires causing short circuits and suspension or dislocation of traffic, are all likely to be reported; for they are occurrences which must come to the knowledge of the chief officials, who, assuming for a moment that they might desire to conceal these accidents, would hardly dare to do so, because of the publicity which is given in general to such things. The case is different, however, with respect to the relatively unimportant or unpublished accidents. Many of these occur, and the damage is remedied in the usual course of work, while the very smallest notice, or none at all, is accorded to them in the records and reports which reach the chief officials from all departments. If there is an excessive number of these minor accidents, and assuming again that it is considered advisable to suppress mention of many, this may be done with the very smallest risk of discovery.

To this hypothetical extent the data collected with much

labour by the Board of Trade are vitiated, but we have no doubt that, nevertheless, they are of much intrinsic value, and we hope that what is of public interest will be given publicity.

It may be for reasons similar to the above that the Board of Trade now notifies, in the letter already mentioned, that it will be content hereafter with much modified reports. Taking the electrical accidents only, out of a total of 13 distinct classes of accidents named on the original form—which itself remains unchanged—10 are now not to be reported unless they cause personal injury or produce some alarming result: one—short-circuit on feeder—is not even mentioned, so, we presume, may be omitted, while there are only two—trolley boom pulled out, and trolley wire *breaking* and falling—which are to be reported in any case.

That is all quite as it should be. When the first returns were designed, the Board of Trade, from excellent reasons doubtless, were almost too thorough. They, as the guardians of the travelling public, must have thought it better to get the tightest kind of grip first of all, gradually slackening as occasion allowed, rather than to increase the pressure of their authority when dangerous practices, or carelessness, were wide spread and full grown. They started by being almost too inquisitive, but they have now reduced their desire to know to a legitimate range.

They have done the right thing in advising tramway authorities of this reduction, although it is probable that they did so to avoid much tiresome delving among the mass of reported accidents for accidents of any note, but we would suggest respectfully that this obviously business-like course of notifying those interested that certain regulations or requirements having become obsolete, or redundant, or irksome, and need be observed or complied with no longer, would not only save some amount of trouble, but chiefly would tend towards the Board and its live regulations being held in greater respect. It matters not whether the regulated objects are individuals—say workmen—or public bodies, such as corporations or companies; directly it is found that certain rules can be honoured in the breach, and nothing said, they will "try it on" with others which perhaps they find it unpleasant to keep. We have in our minds, particularly, certain sections in the regulations relating to electric tramways and lighting.

It is not feasible for anyone to make a code of rules, every one of which shall be applicable from the year 1 to the millenium, and the best law-givers are they that do not condone law-breaking because some of those given have become obsolete, but abrogate them as soon as they discover them to be so, and before the Majesty of the Law is subjected to disrespect.

The Standardisation of Screw Threads.

In our Notes columns of last week, readers will have noticed a paragraph dealing with standardisation, or, perhaps, more correctly, the want of standardisation, which may on occasion lead to an unthought of and most serious state of affairs, as at the recent big American fires. In this case that land of standardisation, the United States, was found wanting at a most critical period, in such an obviously necessary thing as uniformity of firehose couplings in neighbouring cities.

In view of the possibility of such a state of things existing (which, however, we do not think applies to English fire appliances), the notice which Mr. Leslie S. Robertson, secretary of the Engineering Standards Committee, forwards us of a conference convened by the Committee on Screw Threads and Limit Gauges, for the purpose of furthering the information on these matters, is of considerable interest.

Mr. Robertson's letter draws attention to the vital importance of the screw thread question to engineers in this country, and we might add other countries, which largely patronize the old country in connection with engineering work.

With a view to obtaining a more general expression of opinion on this important matter, it is proposed to hold a conference at the Institution of Civil Engineers, on Tuesday and Wednesday, April 19th and 20th, at which it is hoped leading engineers and those interested will be present.

The following are especially asked to give evidence: (1) Users and (2) makers of screws, (3) makers of tools for making and gauging screw; and a series of questions have been drafted under certain headings as follows:—(1) Whether the present Whitworth and B.A. screws are sufficient for all practical purposes; (2) questions affecting the interchangeability; (3) the angle, pitch threadform, &c., of screws; and (4) systems of gauging of screws.

The possibility of establishing a series of standard limits will also be discussed, and gentlemen willing to attend the conference and assist in a satisfactory solution of the above matters, are invited to communicate with the secretary, at 28, Victoria Street, S.W. Apart altogether from the sensational aspect of the case, foreshadowed in our last week's note, the convenience which would attend the banishment of all sorts and conditions of bastard threads from the engineering products of many firms who pose as "original," would appear to merit the earnest co-operation of the engineering community.

Marconi's Wireless Telegraph Co.

The shareholders of this company were cheered at their annual meeting by two statements—first, that the income had exceeded expenditure in spite of the absence of trans-Atlantic transmission, and second, that an arrangement had been come to with the Post Office, from which the chairman anticipated great results. Less was said than at previous meetings about the wireless telegrams superseding cables, and yet enough to revive the hopes of the shareholders in looking forward to larger income from long-distance work. It might be well for the shareholders to consider whether the improved results are possible in consequence of, rather than in spite of, the interruption of trans-Atlantic communication. The receipts include £20,000 from the Admiralty on completing a new agreement. This can hardly be a regular item of revenue, but it suggests the desirability of developing that source of revenue in which the wireless system is king, and not embarking in the expenditure of capital on more ambitious undertakings, except in a tentative way for experimental purposes. The progress of the company might have been greater and more satisfactory if less reliance had been placed on the intangible. Further particulars must be awaited before an estimate can be formed of the nature of the Post Office agreement. The "negotiations" may, after all, only be "pourparlers," and the information given by the chairman was very vague. To raise new capital on the strength of these negotiations may be unwise, and presumably the directors will await the completion and publication of the agreement.

German Thomson-Houston Combination in Italy.—The Allgemeine Elektricitäts-Gesellschaft, of Berlin, and the Thomson-Houston Mediterranean Co. have just formed the Thomson-Houston Società Italiana di Elettricità, at Milan, with a share capital of £240,000. The new company, which takes over the electrical and turbine branches of both its founders in Italy, owes its origin to the recent understanding between the American General Electric Co., and the before-mentioned German company.

DISTORTED ALTERNATING AND ROTATING MAGNETIC FIELDS.

By R. GOLDSCHMIDT.

We are accustomed to consider unloaded induction motors and unloaded transformers or choking coils as identical and as equivalent to inductive resistances. In reality, the connection is only a mathematical one due to the consideration of a *rotating field* of sine form with regard to *space* in the one case, and of an *alternating field* of sine form with regard to *time* in the other case.

With regard to distortion of any sort, however, whether due to the generator voltage curve or to magnetic resistance

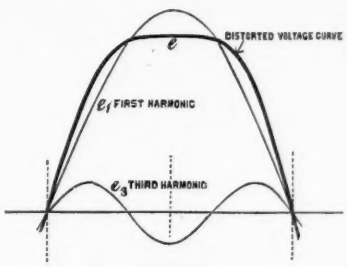


Fig. 1.

and saturation, the reaction of a rotating field is entirely different from that of the alternating field in a choking coil. Whilst the choking coil is practically impervious to voltage distortions, smoothing out all such distortions—*i.e.*, filtering out the higher harmonics—the unloaded induction motor, on the other hand, may almost be compared to a condenser as regards sensitiveness to distortions.

In order to study the effect of a distorted voltage in the two cases without becoming involved in mathematical complications, the simplest possible assumptions will be made. We will construct a voltage curve having a fundamental wave of frequency $v_1 = 50$ periods per second, and a single higher harmonic of three times this frequency—*i.e.*, $v_3 = v_1 \times 3 = 150$ periods. This last will serve as an example of all other higher harmonics. Let the effective value e_3 of the third harmonic be 15 per cent. of that of the fundamental wave e_1. Fig. 1 shows the two sine curves and the resulting voltage curve. Let the voltage e_1 set up a current i_1 in an unsaturated choking coil. Since

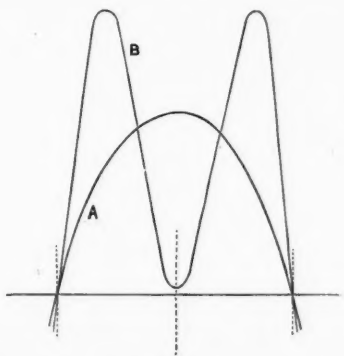


Fig. 2.

$v_3 = 3 \times v_1$, the reactance for e_3 will be three times as great as for e_1, that is to say, the current will contain a higher harmonic component, i_3, of only $\frac{e_3}{e_1} \times \frac{v_1}{v_3} = \cdot 15 \times \frac{1}{3} = 5$ per cent. of i_1. The resultant choking coil current has almost a perfect sine form (A, fig. 2). Its effective value will, of course, be equal to the geometrical sum of the separate components,

$$i = \sqrt{i_1^2 + (\cdot 05\ i_1)^2} = \text{approximately } i_1.$$

The effective value of the combined voltage will be

$$e = \sqrt{e_1^2 + (\cdot 15\ e_1)^2} = 1 \cdot 01\ e_1.$$

The current in a choking coil is, therefore, only very slightly dependent on the voltage wave form.

Let us next consider a two-phase voltage, *i.e.*, the addition of a second voltage of like form and amount to the first voltage, the former having a displacement of 90° in phase from the latter. Suppose that this two-phase voltage is employed to drive an unloaded two-phase induction motor.

Two rotating fields will be set up in the motor: N_1 produced by e_1, and N_3 produced by e_3. N_3 will have a frequency corresponding to three times the speed of N^1. An examination of fig. 3 also shows that the relative position of the phases is different in the case of e_1 and e_3; in e_1 phase II.

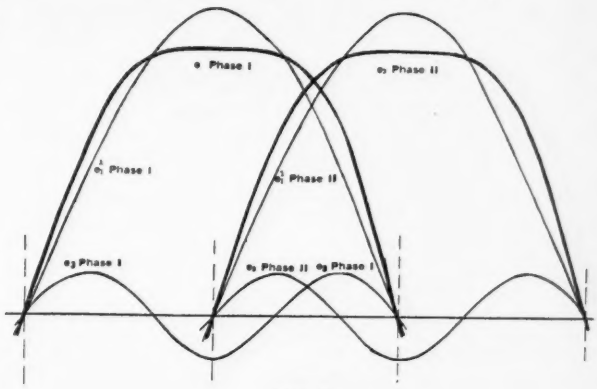
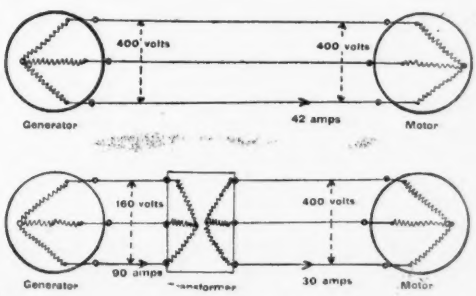


Fig. 3.

follows phase I. whilst in the case of e_3 phase I. follows phase II. This indicates that the directions of rotation of the two fields are opposed. In the case of a six-pole motor, N_1 would rotate at 1,000 revolutions per minute in the positive direction, and N_3 at 3,000 revolutions per minute in the negative direction. The unloaded rotor tends to run synchronously with the rotating field, *i.e.*, in our case at either + 1,000 or − 3,000 revolutions.

Since N_1 (e_1) is much stronger than N_3 (e_3), the rotor will run round at + 1,000 revolutions, and thus have a slip of 133 per cent. relatively to N_3. Now, in a good induction motor, the current set up by a given voltage at a very high slip is about 20 times as great as that at slip 0—*i.e.*, running light (assuming a leakage coefficient of ·05, or $\frac{1}{20}$th). If, therefore, the current set up by e_1 is called i_1, the current set up by e_3 will be $i_3 = i_1 \times 20 \times \frac{e_3}{e_1} \times \frac{v_1}{v_3} = i_1 \times 20 \times \cdot 15 \times \frac{1}{3} = 100$ per cent. of i_1. That is to say, the no-load current receives a higher harmonic component of three times the frequency, and of the same amount as the fundamental component itself. The curve of the no-load current is shown in B, fig. 2, and its effective value is $i = \sqrt{i_1^2 + i_1^2} = 1 \cdot 42\ i_1$, so that the no-load current of the motor is *over 40 per cent. greater with the distorted curve* than it would be with a sine



Figs. 4A and 4B.

voltage. It is clear, from this method of investigation, that it is quite immaterial whether the distorted curve is flat-topped or pointed. The induction motor, therefore, shows great sensitiveness to distortion of the voltage curve, especially to the higher harmonics of the lower orders, such as the third, fifth and seventh harmonics.

The following experiment will serve as a good example of

the above action. A no-load test on a 400-volt 50-period 1,000-revolution 70-H.P. three-phase motor was first carried out, using a small generator which had been designed for about 350 volts 50 amperes. This was over-excited to give 400 volts, and the test (fig. 4A) showed a no-load current of 42 amperes. The test was then repeated, using a 3 : 1 ratio transformer to raise the voltage so that the generator should be working with a much higher current at a lower voltage (fig. 4B), the percentage voltage drop being increased approximately nine-fold. The transformer also had a considerable drop at the load employed. With the same voltage (400 volts) at the motor terminals the no-load current now measured only 30 amperes against 42 amperes when supplied directly from the generator. The chief cause of the difference was curve distortion. In the first test this distortion had full play, whilst in the second the high reactance of the circuit prevented the occurrence of currents of high frequency.

When a distorted voltage curve is employed the reactance of the circuit, *i.e.*, the voltage drop of both generator and transformer, affects the results. Even on the assumption of

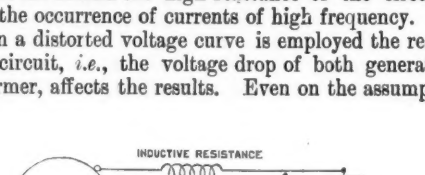


FIG. 5.

similar curve form, therefore, the tests of an induction motor, as carried out in a laboratory, using a small and unsuitably loaded generator, may appear more satisfactory than they will be found to be when the motor is connected to the network of a large supply station. In fact, the discovery of this effect in one or two actual cases induced the writer to make the present investigation.

When the motor is loaded the distorted curve shows itself by an increased current consumption and reduced power factor. Under the above conditions the voltage curve in fig. 1 would give a full load power factor of about ·85, supposing that with a pure sine curve it would have been ·9.

The extra current of high frequency has practically no effect on the voltage drop in the generator; it would only

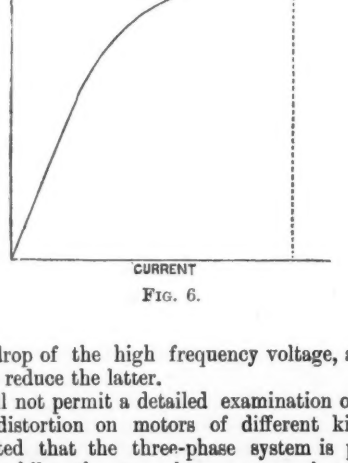


FIG. 6.

affect the drop of the high frequency voltage, and in that way tend to reduce the latter.

Space will not permit a detailed examination of the effect of voltage distortion on motors of different kinds, but it may be stated that the three-phase system is particularly favourable, whilst the two-phase system is particularly unfavourable in this respect.

Though the no-load current of an induction motor is almost as sensitive to distortions of the generator voltage wave as that of a condenser, it is hardly affected at all by distortion of its own field through saturation of the iron. On this point again, unloaded induction motors form a complete contrast to unloaded saturated transformers or choking coils. In the latter apparatus a sine wave terminal voltage will produce a highly distorted current, and a sinoidal current involves a highly distorted counter E.M.F. wave. A saturated choking coil has no definite resistance to an alternating current. Its reactance is, moreover, not only dependent on the flux density in the iron, but also on the remaining self-induction included in the circuit, over and above that of the choking coil itself.

Suppose that the generator A (fig. 5) develops a pure sine wave of E.M.F., which is employed to excite the choking coil D in series with an inductive resistance R. We will assume various values for the latter, and determine the alternate current characteristic, *i.e.*, the effective value of the terminal voltage e_D as a function of the effective

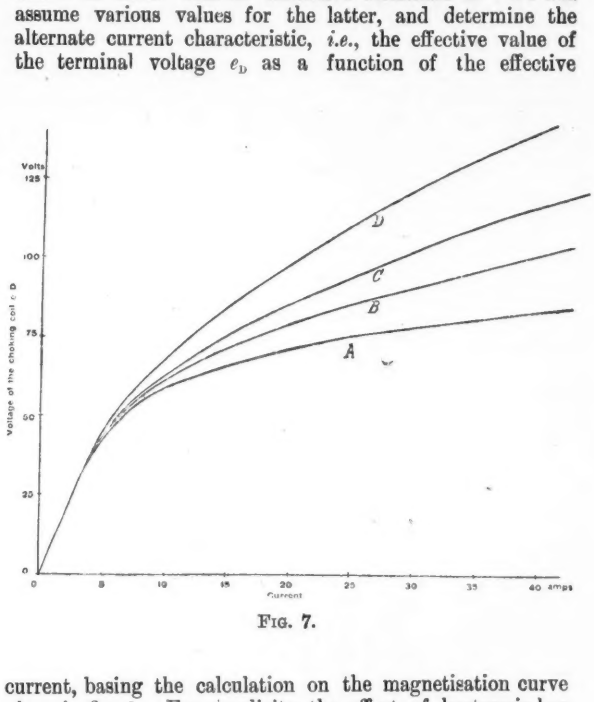


FIG. 7.

current, basing the calculation on the magnetisation curve given in fig. 6. For simplicity the effect of hysteresis has not been taken into account in fig. 6.

As long as the coil is working within the proportional part of its magnetisation curve, its reactance has a quite definite value (S), so that the alternate current characteristic curves for different values of R will lie together during their straight portions (fig. 7). We will consider :—

(A) R = 0.

(B) R = ·3 S.

(C) R = S.

(D) R = very great, so that the reactance of the choking coil is negligible in comparison, and the sine wave E.M.F. of the generator produces a sine wave current.

The calculation of the curves is a simple matter. The ohmic resistance of the circuit is neglected, and using the magnetisation curve (fig. 6), it is only necessary to apply the expression :—

$$\text{Instantaneous value of the E.M.F.} = \text{Change of flux in unit time.}$$

(To be concluded.)

Action of Radium on Vacuum Tubes.—Vacuum tubes are frequently used as detectors of electro-magnetic fields, the presence of which is indicated by the luminescence of the tube. To this effect, the intensity of the field must be upwards of a certain minimum, being characteristic of each individual tube. As pointed out by D. M. Sokoltzew in a paper read before the Section of Physics of the Russian Physico-Chemical Society (meeting of November 11/24th, 1903), the sensitiveness of a vacuum tube may be increased when taking into account the phenomena occurring in such a tube, whenever luminescence is produced under the influence of a potential difference. In fact, an ionisation of the gas contained in the tube will take place, attended by a discharge phenomenon through the gas corresponding to the luminosity observed; the field thus acts as an ioniser. Now, if the field intensity be insufficient to produce this ionisation, the action of another ioniser may be resorted to. On these grounds it occurred to the author to use radium to increase the sensitiveness of the tube. The latter was placed under the influence of an electric field, so weak as to make any luminosity impossible. As soon, however, as radium rays were allowed to act on the tube, a luminosity was noted, increasing with an increase in the effectiveness of the radium.

NORTH-EASTERN RAILWAY ELECTRIFICATION.

A little more than 15 months ago two of the leading railway companies in the North of England decided to convert a portion of their suburban lines to electrical working in the belief that in this way only was it possible to cope with the tramway competition effectively. No time was lost in getting to work, and the engineers of the N.E. Railway actually had trains running experimentally as long ago as September last upon the Newcastle lines, while our readers have already been made fully acquainted with what has taken place upon the Lancashire and Yorkshire system between Liverpool and Southport. On March 29th the North-Eastern opened the first of its electrified sections for public traffic, and on Tuesday, April 5th, the Liverpool and Southport trains were also run for public service.

The first train on the N.E. was started by Lord Ridley at 12.5 p.m. on March 29th, and from 12.50 onwards the full electric service between Newcastle and Benton was opened to the public, and has since been regularly at work. The outward journey took 11 minutes, the return 12 minutes, being a reduction of 25 per cent. on the steam time. The line which Lord Ridley opened is no modified tramway, nor does it resemble the electric railways of the metropolis. It is an old-established and busy branch of a great railway, with a large goods and mineral traffic, and a frequent, if somewhat irregular, suburban service, while at one end of the line is the Newcastle central station, and one of the most complicated junctions in the North of England.

The conversion of such a line is naturally a work involving considerable changes in methods of working, and therefore the directors have shown their wisdom in opening this section of the line first, so as to make the change a gradual one. The rest of the work is practically complete, and will be gradually changed over to the new service as the staff and public become accustomed to it.

The converted routes consist of a double loop of lines on the populous north bank of the Tyne between Newcastle and Tynemouth.

There are 37 miles of double and four-way track equivalent to some 82 miles of single track, over the whole of which the passenger service will now be worked electrically.

For the present the goods traffic will be mainly operated by steam, although two electric goods locomotives are to be used on a portion of the system.

The stopping trains between Newcastle and Tynemouth (some 8½ miles) have hitherto taken 35 minutes, which will now be reduced to 23 minutes, while the express train will perform the journey in 15 minutes, and a regular service will be given every 15 minutes.

Great importance is attached to the service being perfectly *regular*, so that the use of time tables becomes unnecessary; this point is perhaps as important as that the service should be frequent.

The third-rail system is adopted, the current being picked up by a contact shoe from this rail, and, after passing through the motors, returns to the dynamos by the ordinary running rails.

The current is generated at high pressure, 6,000 volts three-phase alternating, at the central power station, and transmitted to sub-stations, where it is converted into low pressure 600-volt direct current, and fed on to the power rails.

Only a certain number of the cars are fitted with motors, there being some 70 motor coaches and an equal number of trailer coaches; but a proportion of the latter are so arranged that the motor coaches in the train can be controlled from them.

After going very carefully into the matter, the railway company came to the conclusion that it would be more profitable to purchase energy from the Newcastle-upon-Tyne Electric Supply Co., already in existence, than to build a separate power station for itself, and after the trial trip a visit was paid to the Newcastle Co.'s works. The new station, which is just nearing completion, contains steam turbines coupled to alternators of a size considerably larger than any at present at work in this country, the maximum output being between 8,000 and 10,000 H.P. The steam is provided by water-tube boilers.

The ceremony, which was of a semi-private nature, attended only by the railway company's directors and officials, representatives of the contractors, the British Westinghouse and British Thomson-Houston Companies, the consulting engineer, Mr. Charles H. Merz, and the Newcastle Electric Supply Co., consisted of a visit to one of the company's sub-stations, followed by a trip over the line from Newcastle to Benton and back, after which the party was entertained to luncheon by the directors at the Station Hotel, Sir David Dale being in the chair. In the afternoon a visit was paid to the Neptune Bank and Carville power houses of the Newcastle-upon-Tyne Electric Supply Co., and also to the sub-stations of the North-Eastern Railway Co., where the high-pressure 6,000-volt three-phase current is converted by means of rotaries to 600 volts direct current, and supplied to the line.

PROFITS AND POPULATION.

[COMMUNICATED.]

During the first years that a corporation electric lighting station is running, past experience has proved that a deficit may be usually expected when the necessary allowances have been made for interest on capital and sinking funds. A greater proportionate deficit is obviously to be anticipated with the smaller lighting stations, and in the present article a number of returns have been analysed on a basis of the population of the area of supply.

The returns have been divided into four classes (1) up to 25,000; (2) 25,000 to 50,000; (3) 50,000 to 100,000; and (4) over 100,000. The division may seem somewhat arbitrary, but almost without exception they may be classed as follows:—

1. Small market and residential seaport towns.
2. Large market and small manufacturing towns.
3. Large manufacturing towns.
4. Large seaport and inland manufacturing towns with residential suburbs.

No station with a traction load has been included, but so far as obtainable, the whole of the returns up to March, 1903, of stations at present giving a lighting supply have been analysed.

The following statement gives the number of returns analysed with those showing a gross and net profit or loss. The first complete year is taken as the first year of working:—

Year of working.	Number of returns.	Gross profits.	Gross losses.	Per cent. of losses.	Net profits.	Net losses.	Per cent. of losses.
1st	66	58	8	12·1	16	50	75·7
2nd	51	48	3	5·8	16	35	68·6
3rd	43	42	1	2·3	17	26	60·5
4th	35	35	—	—	20	15	43·0
5th	27	27	—	—	17	10	37·1
6th	26	26	—	—	16	10	38·6
	248	236	12	4·85	102	146	59·0

Three years elapse before all the stations show a gross profit on the revenue, but after provision is made for interest on capital and sinking fund, they are never all out of the wood during the whole of the six years. These are again re-analysed below, according to the population, showing very clearly that the greatest proportionate losses are made by the small stations.

Population.	No. of returns.	Gross profits.	Gross losses.	% of losses.	Net profits.	Net losses.	% of losses.
Up to 25,000...	54	49	5	9·2	11	43	79·6
„ 50,000...	72	67	5	6·9	30	42	58·3
„ 100,000...	53	51	2	3·8	14	39	73·6
Over „ ...	69	69	—	—	47	22	31·9
	248	236	12	4·8	102	146	59

Out of 248 returns only 102 (41 per cent.) show a net profit, and this without providing anything for depreciation beyond what may have been included in the revenue account.

The next statement shows the percentages that the gross profit, interest and sinking fund, net profit or loss bear to the capital, showing the progress year by year, and again divided according to population.

Year of working.	0 to 25,000.				25,000 to 50,000.				50,000 to 100,000.				Over 100,000.			
	Percentage to capital of															
	Gross profit.	Interest and sinking fund.	Net profit.	Net loss.	Gross profit.	Interest and sinking fund.	Net profit.	Net loss.	Gross profit.	Interest and sinking fund.	Net profit.	Net loss.	Gross profit.	Interest and sinking fund.	Net profit.	Net loss.
First ...	2·4	5·2	—	2·8	3·07	4·94	—	1·87	2·54	4·84	—	2·3	3·5	4·32	—	0·82
Second ...	3·55	5·18	—	1·63	4·0	5 12	—	1·12	3·71	5·31	—	1·6	6·35	5·64	0 71	—
Third ...	4·38	5·76	—	1·38	5·19	5·2	—	0·01	4·07	4·93	—	0·86	6·55	5·53	1 02	—
Fourth ...	4·2	6·28	—	2·08	4·87	4 99	—	0·12	5 02	4·75	0 27	—	6·24	5·15	1·09	—
Fifth ...	3·53	6·05	—	2·52	5·5	5·32	0·18	—	4·0	4·86	—	0 86	6 02	5·37	0 65	—
Sixth ...	4·24	5·52	—	1·28	5·65	5·41	0·24	—	5·34	5·45	—	0·11	5·95	5·32	0·63	—
Average...	3·71	5·66	—	1·95	4·71	5·16	—	0·45	4·11	5·02	—	0·91	5·77	5·22	0·55	—

Generally, the above table shows that towns of less than 100,000 inhabitants have on the average made a loss of 1·1 per cent., and the larger towns have only been able to set aside the sum of 66s. per £100 towards depreciation of plant and machinery after six years' wear and tear.

The following is a comparison of the percentage of gross expenses and profits, interest and sinking fund, and net profit or loss to the gross receipts:—

Year of working.	0 to 25,000.				25,000 to 50,000.				50,000 to 100,000.				Over 100,000.				
	Percentage to gross receipts of																
	Expenses.	Gross profit.	Interest and sinking fund.	Net loss.	Expenses.	Gross profit.	Interest and sinking fund.	Net profit.	Net loss.	Expenses.	Gross profit.	Interest and sinking fund.	Net profit.	Net loss.	Expenses.	Gross profit.	Interest and sinking fund.	Net profit.	Net loss.
First ...	70·4	29·6	64·2	34·6	65·6	34·4	55·3	—	20·9	68·3	31·7	60·2	—	28·7	60·8	39·2	48·3	—	9·1
Second	61·3	38·7	56·4	17·7	60·0	40·0	51·1	—	11·1	61·4	38·6	55·3	—	16·7	45·2	54·8	48·7	6·1	—
Third ...	55·0	45·0	59·2	14·2	59·8	40·2	40·3	—	0·1	57·7	42·3	51·3	—	9·0	49·8	50·2	42·3	7·9	—
Fourth	60·5	39·5	62·0	22·5	57·7	42·3	43·3	—	1·0	53·3	46·7	44·2	2·5	—	49·5	50·5	41·6	8·9	—
Fifth ...	63·7	36·3	62·2	25·9	52·2	47·8	46·3	1·5	—	58·2	41·8	50·8	—	9·0	49·4	50·6	45·2	5·4	—
Sixth ...	65·5	34·5	44·8	10·3	56·2	41·8	40·0	1·8	—	51·2	48·8	49·8	—	1·0	50·3	49·7	44·5	5·2	—
Average	62·7	37·3	58·1	20·8	58·9	41·1	46·0	—	4·9	58·3	41·7	52·0	—	10·3	50·8	49·2	45·1	4·1	—

From this it will be seen that the towns of over 100,000 in the second year have the lowest ratio (45·2 per cent.) of expenses to receipts, the highest being, as might be expected, the smallest towns in the first year, and correspondingly the highest profit falls to the largest populated towns, and the lowest profit to the smallest towns. The interest and sinking fund combined, vary from 40 per cent. of the receipts in the sixth year of the 25,000 to 50,000 towns, to 64·2 in towns of less than 25,000. The average charges upon the receipts under this head are:—

Under	25,000	£58 2 0	per £100 of receipts.
„	50,000	46 0 0	„ „
„	100,000	52 0 0	„ „
Over	„	45 2 0	„ „
	An average of ...	£50 6 0	„ „

A charge on receipts of over 10s. in the £ is a very large proportion, and cannot but be regarded as very serious, and being statutory, it cannot, of course, be avoided. The results are somewhat unexpected, as the most successful stations do not run in the inverse order of the population.

The 50,000 to 100,000 towns are not proportionately so successful as the next smaller class. This may arise from either of the following causes:—

1. The higher percentage of loss in the first few years.

2. The higher capital cost through the load being over-anticipated. There is a tendency for the population of rapidly growing towns to leave the centres as they become more congested, and go out and live in the suburban districts, which are often outside the area of supply. A comparison between the cost per kilowatt installed and kilowatt of maximum load at the end of the first year seems to bear out this contention.

	Price per KW. installed.	Cost per KW. of maximum load during first year.
0 to 25,000...	£103	£222
25,000 to 50 000	93	199·5
50,000 to 100,000	93	211·2
Over 100,000	92	—

Most of the largest stations have been running for some years, and the cost per KW. of maximum load is not stated in the returns.

Much more might be written on this subject, but the figures quoted prove conclusively that those responsible for the guidance of corporation lighting stations are on no bed of roses—at any rate, during the first few years when the load is being developed.

It can scarcely be doubted that the advent of large power companies will be welcomed by the smaller municipalities. Towns and villages that could not otherwise hope to have an electric supply either for lighting or power on account of the capital difficulties to be faced, may then have it on tap without any risk of adding to the ever-increasing burdens of the ratepayers. They will have no plant lying idle, depreciating in value whilst the load is being developed, and no interest to pay on unremunerative capital.

It is to the interest of the power companies to keep their price of supply as low as possible, and the large load and diversity factors enable a lower selling price to be fixed than would be possible in the case of the small stations, this low price, of course, benefiting both user and producer.

THE AGE OF SPECIALISTS.

[COMMUNICATED.]

THE rapid advance of American manufacturing industries is, in the opinion of the writer, largely due to the splendid method and system adopted. The American long since realised that a "jack of all trades" style of concern is based upon radically wrong principles, and results have justified their efforts to do one thing and do that well.

There is room in the kingdom no doubt for one or two large manufacturing concerns, firms which sell everything

electrical, from a Leclanché cell to an alternator, but the number is strictly limited.

The price lists issued by some comparatively small firms are positively pitiable in their efforts to cover the whole of the ground, a sort of "If you do not see what you want in the window, please ask for it," policy. This style of trading is not really wanted. It is not thorough enough to stand, and hence it is that the smaller firms so often come to grief, and capital and energy is wasted. Many a firm long since forgotten might have been doing a flourishing business to-day had it, in the first instance, looked round for some branch of the trade not already too overcrowded, and then devoted the whole of its capital and energies to doing that one thing well, and turning the article out in large quantities. It is, in fact, not at all impossible that in the future we may see large firms established who do absolutely nothing but "assemble" parts which they have purchased in a finished state from other firms of specialists.

It is quite certain that even now it does not pay to make everything used in a factory. Take, for instance, the case of a firm using annually 100 gross of a particular kind of bolt. The bolts in question may be purchased in the market at 3s. per gross, whilst the necessary machinery to produce them would cost, say, £150. Allowing that the firm in question is paying the actual manufacturer a profit of 15 per cent. on his work, we have an extra outlay of £2 5s. per annum.

On the other hand, the firm which decides to make them itself must provide for interest on capital sunk in the machinery, depreciation, and provide skilled labour in that particular branch. The net result is clearly against them on all points.

One result of a mistaken determination to produce every detail down to the very smallest in the finished article, is to crowd the works with a mass of costly machinery which is standing idle for six days out of seven, and literally eating its head off.

Of course each case must be taken upon its merits, and the decision as to how far the principle of purchasing finished parts from specialists shall be carried, must be arrived at according to circumstances.

With the above principle judiciously in operation, an astonishing amount of apparatus may be turned out of a most plainly equipped factory, and by cheap and unskilled labour to a large extent.

The keynote of the whole subject is "specialise." If you are a maker of steam engines, leave the manufacture of motors to someone else; if you are going in for switchgear, go in for it thoroughly, and don't attempt to sandwich in a line of telephones and electric heaters which nobody wants, as the market is already well supplied by large producers.

A point of vital importance to all manufacturers is to thoroughly grasp the requirements of the trade before attempting to design and standardise their apparatus.

If this point is thoroughly mastered at the commencement, it will result in a great reduction in the number of drawings and patterns, &c., required, and enable the manufacturer to continually turn out goods of one design, with a consequent reduction in cost.

GOVERNMENT AND TELEPHONES.

In our article last week we laid stress on the unsatisfactory state to which the telephone situation has been brought by the ill-advised measures adopted by the Government in the past, and pointed out the great necessity of a reconstitution of ruling conditions which will permit of the advancement of British telephony. As we then said, there is more than one way out of the difficulty. Although it is generally suggested that Government purchase and future management of the entire telephone service of the country is the sole solution, that is by no means the case, and if the negotiations are conducted in the spirit of no other solution being possible they are certain to be fruitless. It is notorious that telephony in this country has been prevented from spreading over the wide field of development which it has found abroad, notably in the United States, by the restrictions arising from the legal Government monopoly, and from the various measures passed in the administration of that monopoly. Had private enterprise been allowed a free field, there is little doubt that telephony would have flourished here as it has flourished abroad. At various times in the past, in despair at the complications introduced by the ill-advised action of ministers connected with Post Office administration, we have urged the Government to come to a definite decision—even if that should imply Government management—which would permit of a definite policy of development on sound lines.

The issue now raised is squarely one of Government management *versus* private enterprise. We may leave municipal telephony out of account, as the municipalities have so much misunderstood both the technical and financial requirements of the telephone service, that there is little hope of any sound policy of telephone development in that direction. The question is, then, whether the great development of the telephone service, anxiously awaited by the public, will best be achieved by placing the whole business in the hands of the Government, or by removing the obstructions which have so long debarred private enterprise from developing the service in accordance with the public wants. It should clearly be understood that the most important point is the future of the business. If the telephone service is developed even in moderate proportion to the possibilities of telephone development as they are now understood, the amount of capital required will far exceed that now invested in the telegraphs. The discussion cannot therefore be confined to the simple question of whether or not it is advisable to transfer the present business of the National Telephone Co. to the Post Office. That is really the least part of the problem. A solution must be arrived at which will make the way clear for an indefinite expansion of telephony.

It will be generally admitted that, whoever is to undertake the future conduct of the telephone business, the service must be made to pay its way. Even the Government cannot afford to conduct at losing rates a business which is bound, under a policy of active development, to attain immense proportions. Before asserting positively that Post Office management is best for the future of the telephone business, it is well to ascertain the present results of Post Office management of telegraphs and telephones. In Lord Stanley's recent speech he gave various figures relating to Post Office telephones which were not very complete, and were not clearly understood by the House of Commons. The tenor of the Postmaster-General's statements and figures was such as to cause the impression that the Post Office telephone business is conducted at remunerative rates. The only illustration given by Lord Stanley was an unfortunate one. He stated that the average revenue from the London system was under £8 per subscriber. The average capital cost is £100 per subscriber, and if the Post Office system is to be extended all over London, it will remain near that high figure for a long time to come. An average revenue of £8 per subscriber cannot possibly be a remunerative figure for the London service. The principal reason why the revenue per subscriber is so low is that almost all subscribers are on the toll rate, and this has been fixed at too modest a figure to make a first-class telephone service over the enormous metropolitan area a profitable undertaking. At present the London service, if interest and depreciation charges are taken into account, must be costing the Post Office nearly twice as much as it brings in.

In any analysis of the Post Office accounts it is impossible to distinguish accurately between the working of telegraphs and telephones. It has been suggested in Parliament that separate accounts should be presented for the two branches of the business. If these accounts are obtained, they should afford interesting and valuable information. Meanwhile, we will do the best we can with the latest Post Office returns. The total expenditure on telegraphs and telephones for last year is given in an official return recently issued as £4,325,577, and the total receipts, including £92,121, value of service rendered free to public departments, £3,723,866, making a deficiency of £601,711. From this must be deducted an amount of £490,155, expended during the year on new construction and on sites and buildings, which in commercial practice would go to capital account. This makes the net deficiency for the year on the actual working of the Post Office telegraphs and telephones

£111,556. This is exclusive of interest on the capital of the telegraphs, although, as the capital raised for telephones is repaid by terminable annuities, there are presumably included in the expenditure side of the account payments for interest and sinking fund on telephones.

The working of telegraphs and telephones, as a whole, clearly involves a loss to the Post Office. It then becomes necessary to determine whether the telephones by themselves are remunerative, as we are given to understand by Lord Stanley's remarks. The total capital invested in the Post Office telephone systems was stated to be £4,174,000. The total revenue is not accurately shown in the Post Office returns, but we estimate it as follows :—

Trunk lines	£310,000
Provincial telephone systems, 5,000 subscribers at an average of, say, £7	35,000
London telephone system, 15,300 subscribers at £8	122,400
	£467,400

This estimate of the gross revenue from Post Office telephones is sufficiently accurate for practical purposes, as the only item not confirmed by the official figures is that for the provincial systems, which we have put probably over rather than under the mark. In the trunk line revenue we have allowed an increase of £36,000 over last year's results. According to these figures, the gross revenue is just over 11 per cent. on the capital expended. No technical reader requires to be told that this ratio of gross income to capital is not sufficient to yield a profit on a service involving a costly and complicated plant, subject to high maintenance and depreciation charges, and a large amount of skilled labour.

It cannot justly be claimed, therefore, that the present investments of the Post Office in telephones are remunerative, and it is obvious that, if the present rates for service are maintained, they will not be remunerative in the future. Under these circumstances, which we think are by no means generally appreciated, the advisability of entrusting the Post Office with the future management of the telephone service of the entire country is open to discussion. The difficulties which have occurred in the past with the telephone service, and have culminated in the present crisis, have arisen, not because the telephone business has been in the hands of private enterprise, but because that enterprise has been fettered by constant political interference. Had there been "free trade" in telephony, the situation to-day would have been very different. Should the case for Government management not be fully proven in the proceedings lately begun, and, should Parliament fail to ratify the Post Office project of exclusive telephone monopoly, it is to be hoped that the alternative will not be a continuance of the policy of limited licences, but the adoption of a policy embodying a sufficient measure of free trade to encourage a broad development of British telephony.

ENGLISH METHODS IN THE ASCENDANT.

Great interest has of late been aroused by the unexpected performances of the "new tool steels." These new steels are peculiar in that they will continue cutting when even red-hot, and their performance is many times that of the old carbon steels. There is nothing particularly vicious in a red heat, any more than there is in any other temperature, but it is simply a temperature which has been quite outside the working range of metals.

The new steels, however, are widely different from anything previously met with. The very full tests to which several brands have been subjected by Prof. Nicolson, of Manchester, have shown, when boiled down to concentration, that the most efficient work is done at the heavy cuts. The speeds at which the new steel will work are greater than the speeds of the older steels, but the essential point which is established, is that heavy cuts even at a less speed are preferable to light cuts. English practice has always been in the direction of heavier cuts than American practice.

American machine tools were run fast at light cuts, and in this way the lightness of the tools was masked. The earlier American tools sent over here were particularly light and flimsy, and often failed under English conditions. The makers, of course, blamed English clumsiness for the breakages, which were really due to the inability of the American makers to realise English conditions.

It has taken them a long time to do this, but later American machine tools have been built much more closely to English ideas of strength and weight, though still somewhat lacking as a rule. English machine tool makers, up to within quite recent years, played into the hands of the Americans by sheer carelessness and laxity. Old designs were made to do duty far too long, and the result was that the Americans were able to step in very successfully, and thousands of their machine tools came into this country, so that at one time the smart Yankee thought that he was about to sweep the board, and the Germans who had commenced to make copies of American models were also very sure of doing a big business here.

The new tool steels have done a good stroke of work for English machine tool makers. They have shown everyone clearly that the machine tool of to-day must be an exaggerated improvement on English practice and not a strengthened-up American practice. The enormous stresses now carried at the point of a tool demand, not merely that the driving mechanism must be powerful and strong, but also that the carriage must be heavy, and, indeed, the whole machine must be heavy in proportion.

To supply such machines is but a step in advance for the English designer, whose wakening up has fortunately taken place just nicely in advance of the discovery of the new steels and their now very general adoption by manufacturing engineers. The gearing on all machines must be immensely increased. The small light fine tooth narrow gear wheels of German machine tools are quite hopelessly behind time to-day, and very few German tools could now be satisfactorily employed in a modern workshop.

Only a few years ago the position of the English machine tool trade seemed well nigh hopeless, but to-day a complete reversal of affairs is seen, and the new steels will only serve to accentuate matters in favour of the home production.

American tools with their convenience of handling and fair design would have taken much firmer hold than they did, but for two or three objections. First, the Americans would not recognise that the hard materials of this country were here for a permanency; and secondly, they did not grasp the idea that the Englishman desired durability. Most of the American tools were too soft to last very long and do accurate work. And finally, while Americans began to trade upon dumping lines, they raised prices excessively upon second orders, and spoiled their market. The American machine tool, which will now sell over here, will no longer have the advantage of design, convenience or rapidity. All the toolmakers here have taken a fresh start, there is going to be a big demand for strong and powerful tools, and no tool makers in the world are better fitted to cope with that demand by training and instinct than the much-abused heavy-handed Englishman. The era of inordinate cheapness has probably begun to wane. We hear of customers of heavy English pumps, who tried the cheap duplex products of America, turning back to the old makers again, and the same experiences are being gone through in all branches of engineering. Soundness and durability are coming back to fashion, and English work is coming into vogue again, because cheap things have been tried and found wanting.

PARLIAMENTARY.

Wolverhampton Corporation Tramways.

This Bill came before the Police and Sanitary Committee of the House of Commons on March 28th, the chairman being Mr. Heywood Johnstone. The promoters were represented by Mr. Ram, K.C. The Bill was to empower the Corporation to construct tramways and to make further provision in regard to their tramway and electricity undertakings. The new tramways were estimated to cost £10,196. The Bill was an omnibus Bill, and contained provisions for the widening of a bridge and other minor matters. Tramway No. 1 was to be constructed on the Wolverhampton road in the urban districts of Heath Town and Wednesfield, and would commence by a junction with Tramway No. 8, authorised in 1899. The line would be 4 furlongs 9·7 chains in length, it would be a single line with loops, and would terminate near the eastern corner of New-street. Tramway No. 2 would be 3 furlongs in length and a single line with loops, commencing at a junction with tramway No. 1 at its termination, and passing along the Wolverhampton Road, Rookery Street, and High Street, would terminate in the March End Road. That part of Tramway No. 2 which would be on the bridge over the Wyrley and Essington Canal was not to be constructed until the bridge was widened. The tramways would be worked on the Lorain surface-contact system of electric traction.

Mr. S. Craddock, the deputy-chairman of the Tramways Committee of the Corporation, was called, and said that the localities through which the tramways would pass were in favour of the scheme. In reply to a member of the Committee, he said that the system to be adopted was the stud system, which was already in use and had proved very successful.

Mr. G. Greene, the borough engineer, also spoke in favour of the Bill.

After hearing further evidence, the Committee passed the preamble of the Bill so far as the tramway scheme was concerned. Other sections of the Bill, including one for powers to run motor-omnibuses, were then considered.

Lincolnshire and Yorkshire Electric Power Bill.

This Bill came before the Court of Referees on Tuesday, March 29th, for the consideration of objections raised to the *locus standi* of several of the petitioners against the Bill. The promoters seek power to incorporate a company to supply electrical energy over a wide area in Lincolnshire and Yorkshire. Power is also sought to acquire land for generating stations and to lay down mains. The capital asked for is £999,000.

Mr. Freeman, K.C., on behalf of the Yorkshire Electric Power Co, contended that his clients had a *locus*, inasmuch as the Bill contained clauses giving the promoters the right of competition within the area authorised by the Act of 1901 as the area of the Yorkshire Electric Supply Co. Mr. Lynden Macassay, for the promoters, replied that no new powers of competition were sought; there was only a power to accept the transfer of any existing rights owned by any local authority, subject to a Board of Trade provisional order. After consultation the Court disallowed the *locus*.

The *locus* of a Mr. A. H. Fryer, a miller, who petitioned on the ground of the interference with the flow of the River Rase by wells proposed to be sunk by the promoters, was disallowed, as was the *locus* of the Lincolnshire Ironmasters, who contended that the district within which they supplied electricity should not be included in the company's area.

Sir Hickman B. Bacon, the owner of a considerable estate in Lincolnshire, was allowed a landowner's *locus standi*.

London United Tramways Bill.

The Court of Referees considered the *locus standi* of the Brentford Urban District Council in regard to this Bill on 29th ult.

Mr. Weddeburn, K.C., appeared for the petitioners. He said that the tramway company proposed to continue their line from Hounslow to Staines. The line would be converted into a through light railway, and the character of the traffic would be entirely altered. The Urban District Council contended that there should be certain widenings where the line passed through Brentford. The local authority should also have some control over the traffic. There had been over 400 accidents in the thoroughfare in question during two years. The Court disallowed the *locus* of the Council on all points excepting the question of time limit for Tramway No. 7, authorised in 1898.

The *locus* of the South-Western Suburban Water Co. was also disallowed.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Recent Developments in Metal Conduits for Electric Light Installations.

As one interested in wiring, I notice the short and curt manner in which wood casing is condemned and dismissed in the above article, which appeared in your last issue. I do not for a moment wish to say that wood casing should be used in all electric light installations, but neither is metal conduit to be universally adopted in all cases. Your contributor has briefly enumerated the supposed drawbacks of wood casing as follows:—

1. "It is not fire-proof, and, in fact, it is highly inflammable."

Does anyone claim that wood is not inflammable? And its universally recognised inflammability does not debar wood from being largely used by all branches of the building profession. To refer to this disadvantage, therefore, is simply to accentuate other greater counterbalancing advantages which wood casing must possess to justify its very general use in spite of such a very obvious defect.

2. "It absorbs moisture to a large extent, and is actually dangerous."

This also is so obvious that no electrical engineer would ever think of recommending the use of wood casing in a place where moisture was present or likely to develop. A very large percentage of electrical installations are carried out in buildings which are water-tight and damp-proof, and to that extent this objection to wood casing goes by the board. Moreover, a considerable amount of the iron tubing, of the split Simplex type, installed during the past five years in damp places, is now in a state like to that of an American railway I know—a streak of rust and a right of way.

3. "It requires special labour at a high rate for its erection, which is necessarily slow, especially when neat work is demanded."

In spite of this your contributor admits that wood casing is cheaper to install than iron conduit.

4. "It cannot be said that it lends itself to the surmounting of obstacles frequently met with in wiring, such as cornices, paper mouldings, &c."

The reply to this objection is: Circumstances alter cases; it all depends. There are cases where wood casing is more suitable than iron conduits, and there are other cases where the reverse is true. In passing, one would like to ask the advocate of the pipe system how the boast of erecting the pipes first and drawing in the conductors afterwards is to be managed after the pipe has been bent and twisted round obstacles?

5. "Accurate mitring of the casing and cover is essential wherever the run deviates from a straight line."

Granting this to be true, are we to believe that the bending, cutting, and screwing of pipes, in a manner sufficiently careful to permit of the conductors being afterwards placed in position, without damage to their insulation or covering, is, in comparison, such a simple matter that wood casing is to be dispensed with in favour of tubing on that account? A moment's consideration will show that this objection is one of those half truths which hold good only so long as the whole truth is kept modestly out of sight.

6. "Special arrangements, never satisfactory under the best conditions, have to be made for wire crossings."

The special arrangement consists of a short piece of casing carried on the top of the other casing, and in my experience is entirely satisfactory. This is not gainsaying your contributor's objection in this connection, but one assertion, unsupported by argument, is as good as another.

8. "The whole system lends itself to covering bad workmanship." With wood casing the workmanship exhibited on the outside of the system may be taken as a fair indication of the nature of the work hidden behind the cover of the casing. In the case of iron pipe there is, of course, no such external guarantee of inward care. With wood casing one can specify that a properly trained joiner shall be employed, and for the tearing up and relaying of floors, cutting joists, wooden dados and other woodwork necessitating some slight knowledge of building construction, the joiner is much to be preferred to the nondescript cross between a plumber and a labourer who is so often employed for the erection of iron pipe systems. But, apart from this altogether, in the writer's experience, there is as much shoddy work hidden away behind compact-looking iron pipes as there is below the covers of the much-maligned wood casing.

9. In conclusion: "Wood casing can never be looked upon as a satisfactory mechanical protection for electric circuits." This, again, depends upon circumstances. There are most certainly many cases in which wood casing provides all the protection required. One would imagine, when listening to iron pipe enthusiasts sometimes, that householders and shopkeepers spend all their spare time driving nails in all the less likely parts of their premises. A moment's thought will show that lead, compo and hard block tin pipes, used for conveying gas in this country, are even more at the mercy of such contingencies than wood casing, and yet gas leakages, comparatively speaking, are very rare indeed, and, even where they do occur, are seldom the result of the operations of the imaginary nail-driving fiend.

I do not wish to further trespass on your space by enumerating what I think are the defects of iron piping systems, but I thought I would like to enter a mild protest against the wholesale and entirely gratuitous condemnation of wood casing in an article entitled "Recent Developments in Metal Conduits." Wood casing has done yeoman service in the development of electric light wiring in days gone by, and to-day it still stands in the forefront in the opinion of many of the best and most experienced electrical contractors.

Doubleyou Ell.

Small Gas Engines v. Electric Motors.

You courteously published a letter from me on March 11th. In your issue of March 25th, Mr. H. Mensforth attempts to criticise my letter. He must have mixed the point that my figures were given from the gas and electricity bills respectively. He surely would not have attempted intentionally to throw doubt on ascertained facts by a

theoretical computation. However, his attempt breaks down in the first paragraph (the penultimate of his letter), as is usually the case with such calculations. He makes the obvious slip of assuming that the full-load efficiency of the motor will be a constant for a varying load. It is hardly necessary to add, therefore, that he obtains as a consequence erroneous figures throughout.

James S. Wylde.

Liquid Fuel.

While thanking you for your too favourable review of "Liquid Fuel," may I correct what I think is a misunderstanding of my meaning in reference to the combustion of bituminous fuels?

Your reviewer appears to think that I limited furnace temperature to 849° F. (p. 101), but he appears to have overlooked the words "if . . . . those parts of the coal which volatilise and burn as flame be gathered unburned." My object was to show that bituminous fuel burns in two operations—the solid carbon on the grate, the volatile carbon at any distance beyond it.

The ordinarily accepted value for the calorific capacity of carbon is 8,137·5 calories per kilo. The actual value (see table, p. 363) is 11,367 5 from carbon as vapour (or 14,647 and 20,461 B.Th.U. per lb. respectively). The difference, 3,000 calories, is what I refer to as absorbed at the grate in vaporising the volatile carbon, which, of course, can only volatilise at ordinary furnace temperature by entering into combination with another element or elements.

The net result of burning volatile carbon is—subject to endothermic or exothermic considerations, into which I need not here enter—8,137·5 calories, and the ultimate temperatures obtained are all your reviewer claims when the "*gathered up unburned portions*" are finally burned.

My quarrel with everyday practice is that no steps are taken to protect the comparatively cold furnace gas so that it may undergo the secondary combustion necessary to give back the heat absorbed in vaporisation.

Could carbon be burned and the product of combustion recovered as a solid, the calorific value of 11,367·5 would be secured plus the latent heat given up by the oxygen in solidifying, but we have no convenient pit of temperature into which to let fall furnace products, and must, therefore, content ourselves with the 8,137 calories of net effect.

As regards the furnace temperature of 849° F., this, of course, assumes the entire removal unburned of the volatile matters. In actual practice, of course, the volatilised matters do begin to flame at once, and furnace temperatures are not so low as 849° F. But the combustion only takes place under difficulties, because the furnace environment is cold and antagonistic, and provision should be made to conserve temperature until combustion is either completed or so far in progress that it can complete itself before too much heat-absorbing surface has been encountered.

I think I make this clear lower down the same page 101, and the high temperatures that can be got with bituminous fuels (in proper furnaces) are no argument against my theory, and *are* a powerful argument in support of my practice.

I need not follow the argument *re* selective affinity and preferential combustion of hydrogen. Like the bishop, I have friends in both places, and I would refer to my friend, Mr. B. H. Thwaite, in support of my own views. I think his gas engine practice and experience entitled to weigh down the scale as against the producer.

If there is no preferential combustion of hydrogen, may I ask why the flame of an ordinary batswing burner is blue at the outset, the carbon not even glowing until it arrives at the outer parts of the flat flame?

W. H. Booth.

2, Queen Anne's Gate, S.W.

Sine Wave Alternating Currents.

We beg to refer to the article written by Mr. Clifford C. Paterson in your issue of January 29th (Vol. 54, page 165), and would call your attention to the fact that the Maschinenfabrik Oerlikon make use also of other means to influence the sine wave of alternate currents besides the one described in the article alluded to. In fact, we have already, in 1899, in the case of a 100-kw. three-phase generator, supplied to the laboratory of the Swiss Polytechnic School at Zürich, modified the wave curve of the electromotive force, that is to say, produced a nearly pure sine curve by setting the whole pole core with the magnetising coils obliquely on to the magnet rim. Two sets of screw holes have been drilled into the pole cores in such a way that the line joining one set makes an oblique angle with the line joining the holes of the other set. In this way the pole cores could be set either exactly parallel to the axis or be displaced in an oblique angle to the axis.

In the case of this special generator, the magnetic system was stationary and the armature with the slip rings rotating. Of course, the same means can be applied in the case of rotating field magnets having pole-pieces screwed on to them, unless for any reason it is desirable to make only the pole edges oblique either in a continuous or zigzag line.

Maschinenfabrik Oerlikon.
E. Huber.

Barrow-in-Furness Municipal Electrical Supply.

My attention has been drawn to your analysis of the accounts of the above undertaking, published in your issue of the 18th inst., and I shall be obliged if you will allow me space to point out that your method of analysing these (and I presume also the accounts of other undertakings) is not only misleading, but is such that your analyses are practically valueless for the purpose of comparison.

On the debtor side of the accounts under review, there are two items, which certainly should not be included under "total works costs." The items are:—"Private mains and services, £226," and "public lamps, £142." The first of these represents the cost of laying cables, &c., for consumers through private property, and on the credit side the sum of £282 is shown to be the amount received from this source, the profit thus being £56. You will, I think, admit that the fact of work of this description being undertaken should not make it appear that the total works costs per unit are higher than they would have been had the work not been undertaken. Similarly, the inclusion of cost of carboning, &c., under "Public Lamps" in the total works costs makes it impossible to compare the results obtained in works where public lighting is undertaken with the results in works which have no public lighting. The cost of production in two works might be exactly the same, and yet, from your analysis of their accounts, it would appear that the total works costs per unit of the undertaking with public lighting were higher than those of the works without any public lighting.

I hope that, having had your attention drawn to these anomalies, you will see your way to modify your method of analysing the accounts which you will soon be receiving for the year ending on the 31st inst.

H. R. Burnett.

March 28th, 1904.

[Our correspondent's letter raises some interesting and highly debatable points in connection with the methods which should be adopted in arriving at the works costs and the total working expenditure; it is one thing to reduce working expenditure "on paper," and another thing to make an actual reduction.

The fact that Mr. Burnett's department undertook the work of laying private mains and services, incurring extra expenditure thereby (of course, with an ultimate view to a profitable transaction and increased output), is sufficient to account for its inclusion under working expenses. We further note that in the corporation accounts this item is not scheduled "special" or otherwise distinguished.

In the matter of arc lighting, the cost of attendance and carbons is likewise a necessary expenditure incurred by the department solely with a view to earning a revenue, and for this reason must find a place under working expenditure.

It must also be evident to our correspondent that this expenditure having been made and a corresponding revenue earned, any deductions made would have the effect of diminishing the actual figures, which, if justifiable from the engineer's point of view, is certainly not so from the point of view of the general reader—who would hardly expect to find items of "profit" only, on the credit side of a revenue account.

In regard to the latter portion of our correspondent's letter, having obtained the advantages of steady load and increased output, associated with public lighting, he is apparently yet unwilling to admit, when comparing his results with those of his less fortunate neighbours, the slight extra expense to which he has been put.

Public lighting usually demands some extra expenditure, and the "Works and Distribution Costs" in the ELECTRICAL REVIEW columns (which are specified as including public lighting expenses, if such is included in the undertaking, and, as implied in the title, do not pretend to represent the so-called "costs of production") are strictly comparable. The term "Total Works Costs" is, perhaps, somewhat misleading, though we believe it is generally regarded as synonymous with total working expenditure, which, strictly speaking, includes every item of expense involved in the generation and distribution of electricity, including special expenditure on mains, if undertaken out of revenue, as is frequently the case during changing over distributing systems; but such special expenditure is always noted in connection with the works costs, if attention is drawn thereto in the corporation accounts.

As there are considerable divergencies of opinion on the points raised by Mr. Burnett, we shall be pleased to receive the views of our readers thereon.—EDS. E.R.]

Disclaimer.

We notice in your issue of the 31st ult., a reference to the case of the Pearson Fire Alarm Syndicate, Ltd., *v.* Pearson. We desire to point out that this company is not connected in any way with the syndicate referred to, and has no interest whatever in the dispute.

The Pearson Fire Alarm, Ltd.,
H. S. KEATS, *Secretary.*

London, E.C.

[NAME WANTED.—"Manufacturer" wants to know who are the manufacturers of the "Speer" carbon brushes, which, he believes, are made in America.—EDS. E.R.]

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING MAR. 31ST, 1903		WEEK ENDING MAR. 29TH, 1904.	
Ade'aide	Value £31	Alexandria	Value £76
Alexandria	155	Amsterdam	60
Amsterdam	10	Antwerp. Elec. fuses	396
Bombay	51	Auckland	65
Bremen	252	Bombay	1,055
Buenos Ayres. Teleg. mat.	61	" Teleg. mat.	29
" Teleph. cable	98	Bremen	110
Calcutta	1,862	Buenos Ayres	256
Cape Town	1,668	" Teleg. mat.	435
" Teleg. mat.	5,450	Calcutta	540
Colombo	166	" Elec. machinery	225
Delagoa Bay	10	" Teleg. mat.	130
Durban	413	Cape Town	784
" Teleg. mat.	882	" Teleg. mat.	1,150
East London	38	Colombo	18
Gibraltar	480	Delagoa Bay	214
Hamburg	22	Durban	1,306
" Teleg. mat.	50	" Teleg. mat.	70
Hobart	1,766	East London	20
Larache	47	Fanning Islands	20
Lisbon	57	Fremantle	111
Madras	96	Gibraltar	64
Malta	17	" Elec. machinery	1,836
Melbourne	185	Grenada	27
" Elec. motors	466	Hamburg. Teleg. mat.	290
New York	108	Hong Kong	100
Perth	213	Launceston	66
Rangoon	235	Lyttelton	125
Rio de Janeiro	26	Mauritius	19
Sekondi	40	Melbourne	190
Shanghai	91	Mombassa	23
Sierra Leone	20	New York. Teleg. instruments	620
Singapore. Teleg. mat.	62	Penang	10
Sydney	25	Perth	260
Valparaiso	95	Rosario. Teleg. mat.	909
Wellington	403	St. John's, N.B.	78
Yokohama	608	Shanghai	205
		Singapore	21
		" Elec. cable	3,380
		Sydney	696
		Valparaiso. Teleg. wire	51
		Vera Cruz	21
		Wellington	459
		Yokohama	1,044
		Zanzibar. Teleg. mat.	40
Total	£15,739	Total	£17,538

Foreign Goods Transhipped.

Calcutta. Elec. fans.	Value £1,490	Durban. Elec. goods.	Value £84
Gothenburg. Teleg. apparatus	28	" Telephones	1,540
Hong Kong. Elec. apparatus	60		
Total	£1,578	Total	£1,624

Electrical Wares Exported.

WEEK ENDING APRIL 7TH, 1903.		WEEK ENDING APRIL 5TH, 1904.	
Adelaide	Value £793	Alexandria	Value £33
Amsterdam	95	Amsterdam	31
Bombay	183	Buenos Ayres	43
" Teleg. mat.	56	Calcutta	172
Buenos Ayres	74	Cape Town	785
" Teleg. mat.	250	" Teleg. mat.	1,425
Calcutta	400	Colombo	120
" Teleg. mat.	50	Delagoa Bay	441
Cape Town	416	Durban	193
" Teleg. mat.	1,478	" Teleg. mat.	1,086
Colombo	135	East London	103
Durban	2,089	" Elec. machinery	378
" Teleg. mat.	669	Ghent	20
East London	395	Gibraltar	91
Gibraltar	95	Hamburg	16
Hamburg	10	Hong Kong	128
Hong Kong	346	Launceston	100
Liban	17	Lisbon	164
Madras. Teleg. mat.	112	" Teleph. mat.	70
Malta	20	Lyttelton	55
Melbourne	1,305	Madras	297
Mozambique. Teleg. mat.	190	Mauritius	165
Ostend	60	Melbourne	89
Penang	33	Oporto. Elec. cable	1,577
Perth	135	" Teleph. mat.	192
Port Elizabeth	362	Otago. Elec. cable	1,582
Rotterdam. Teleg. mat.	18	Paris	723
St. Petersburg	16	" Electric light machinery	629
Smyrna	32	Penang	23
Stockholm. Teleg. mat.	103	Perth	102
Sydney	669	Pireus. Teleg. instruments	536
Syra. Teleg. mat.	114	Port Elizabeth	41
Wellington	576	" Teleg mat.	1,897
" Teleg. mat.	814	Singapore	331
		" Teleg. mat.	153
		Salina Cruz	14
		Sydney	753
		" Teleg. mat.	720
		Wellington	64
Total	£12,060	Total	£15,291

Foreign Goods Transhipped.

Rio Janeiro. 49 tons teleg. wire	Value £—	Azores. Elec. mat.	Value £56
Shanghai. Elec. mat.	98	Cape Town. Elec. machinery	150
		Durban. Elec. apparatus	108
		East London. Elec. mat.	76
		" Elec. machinery	89
		Melbourne. Telephones	53
		Sydney. 200 elec. lamps	—
Total	£98	Total	£526

Electrical Works in Belgium.—A Continental correspondent writes:—"Affairs as regards the two principal electrical works in Belgium, the Ste. Anme Electricité and Hydraulique, of Charleroi, and the Cie. Internationale d'Electricité, of Liège, have, for a long time, been in a far from flourishing condition. On Saturday last the 250-fr. ordinary shares of the former were quoted at 73·25, and the 500-fr. shares of the latter at 134·50. These two companies had combined, and were pushing a campaign on national grounds, to obtain the order for the construction of the new central station at Brussels. To the general stupefaction of the industrial world, it became known on Saturday that the E. and H. Co. had withdrawn their submission. This will probably put the Cie. Internationale out of the running for this contract, and the outlook for this company must now be gloomy indeed. The cause of the withdrawal of the E. and H. is not difficult to arrive at. The German Trust, with the Allgemeine Electrical Co. at its head, was determined to have the Brussels command, and they have not stopped at buying up the Ste. E. and H. to remove opposition. The price to be paid for the active and passive will probably be about 6,000,000 fr. The 500-fr. preference shares (obligations) of E. and H. are now quoted at 320."

Sunbeam Lamps.—We understand that the Sunbeam Lamp Co. has received a large contract from the War Office for three years, and has also been the successful tenderer to the Corporations of Derby and Grimsby. In order to cope with the increasing demand for the Sunbeam lamps, extensions are proceeding at the Gateshead works.

Liège Universal Exhibition, 1905.—British manufacturers of electrical mining plant will probably find this Exhibition worth their attention. The use of electricity in Belgian mines, even for lighting, is rare at present, but plants are being installed and there is no reason why our manufacturers should not have their share of this work. The enormous coalfields in the Limbourg province will also soon be opened up, and will certainly be fitted up with all the latest appliances. Experts will find this section of the Exhibition full of interest, and those who visited the recent Dusseldorf Exhibition will be able to note the progress made in this industry. The Exhibition Co. will shortly open offices in London; in the meantime intending exhibitors should apply to the Executive Committee at Liège for prospectuses.

Glasgow Industrial Exhibition.—In connection with the Glasgow East End Industrial Exhibition which closes on Saturday, first gold medals have been awarded to the following electrical firms:—Messrs. Lowdon Bros. & Co.; Paterson, Cooper and Co., Ltd, Paisley; Bruce Peebles & Co., Ltd.; the British Electric Plant Co., Alloa, N.B.; the Simplex Steel Conduit Co., Ltd., Birmingham; and the British Westinghouse Electric Co.

Catalogues and Lists.—The CHLORIDE ELECTRICAL STORAGE CO., LTD., have just issued a handy little catalogue (62 pp.) of their "Exide" accumulators which have been put upon the market for electric vehicles and for ignition purposes. Tables of prices, outputs, and dimensions, rules for charging and discharging, and for properly caring for the cells, and much useful information are given.

Dissolutions and Liquidations.—In the High Court of Justice some days ago Mr. Justice Buckley, sitting for the disposal of companies' business, had before him a petition by James Hinks & Sons, Ltd., for the winding-up of H. Sutton & Co., Ltd., of Muswell Hill. His Lordship ordered the petition to stand over till next sittings in order that it might be advertised in a London paper.

The British Electric Separating Co., Ltd., of Swansea, is winding up voluntarily for purposes of reconstruction, with Mr. R. P. Pike as liquidator.

A meeting of the Electric and General Contract Corporation will be held at Coventry on May 6th, to hear an account of the liquidation from the liquidator (Mr. E. F. Peirson).

The Electric Lighting and Fittings Corporation will meet at Cook Street, Liverpool, on May 9th, to hear an account of the winding up from the liquidator (Mr. Simon Jude).

Personal.—Mr. Haydn T. Harrison, who has for a long time made a speciality of electric street lighting in conjunction with the Improved Electric Glow Lamp Co., Ltd., has severed his connection with that company, and has been appointed manager of the Street Lighting Department of the Reason Manufacturing Co., Ltd., of Brighton, whose London offices will now be at 11, Victoria Street, Westminster, S.W.

"Robertson" Lamps.—In the current issue of the *Windsor* magazine there appears an interesting article on the manufacture of "Robertson" incandescent lamps at the Hammersmith works, by Harry Golding. The article is illustrated with photographs, showing the various operations involved, and is well-written from the popular point of view; it concludes with sage advice regarding the comparative merits of British and Continental lamps, and the wisdom of replacing old lamps with new.

Improved Percussive Drill.—We have received from Mr. G. H. Armstrong, electrical engineer, of Chester-le-Street, Durham, a description of his new air-driven percussive drill for boring rock, coal, and similar substances, which he is introducing. He claims that it will drill a 2½-in. diameter hole through 12 in. of the hardest freestone in three minutes.

British Westinghouse Contracts.—Among the contracts recently secured by the British Westinghouse Co., are the following:—

South London Electric Supply Corporation.—12 50-kw. and six 18-kw. transformers.

Coventry Corporation.—12 50-kw. transformers.

Islington Borough Council.—Supply of meters for twelve months.

Sydney Corporation.—Single and polyphase meters for twelve months.

German Electrical Machinery Imports.—A falling-off took place last year in the imports of foreign electrical machinery in Germany, as will be seen from the appended table:—

	1903. Tons.	1902. Tons.
Switzerland	399	518
Austria	247	333
Belgium	72	110
France	67	109
United States	63	135
Gt. Britain	40	118
Other countries	121	111
Total	1,009	1,434

The aggregate value of the imports in 1903 is returned at £80,750, as compared with £114,750 in 1902.

Fiji.—The Government authorities of Fiji have lately given a decision to the effect that "electrical batteries imported for use in connection with marine oil motors" are to be admitted free of duty.

Colliery Plant.—The South Medomsley Colliery have recently placed an order with the British Westinghouse Co., Ltd., for a complete electric power and lighting installation for their pits.

Hyatt Roller Bearings.—Although it is only six months since the Hyatt Roller Bearing Co.'s large shops at Harrison, N.J., were completed, the demand for Hyatt bearings has made it necessary to make a large addition to the machine shop.

Belfast Electricity Works Extension.—Following on the five 400-kw. sets, which Messrs. Mather & Platt, Ltd., have already supplied for this electric lighting station—four in 1899 and one in 1900—they have now received the order for a sixth set, also of 400-kw. capacity, generally similar to the one supplied in 1900, but embodying several new and improved features in the design of both dynamo and engine. The engine is one of Belliss & Morcom's self-lubricating three-crank three-cylinder triple-expansion type, running at 330 revolutions per minute and designed to work either condensing or non-condensing with steam at 160 lbs. pressure and superheated 50° F. The dynamo is a six-pole machine, compound wound to give a normal output of 400 kw. at voltages from 440 volts to 550 volts, and will be capable of standing an overload of 25 per cent. The yoke ring and poles are of cast-steel, split horizontally; the armature is of standard type with a drum winding in a slotted core. The machine is carried upon an independent bedplate provided with flanges for bolting up to a similar bedplate carrying the engine.

For Sale.—On April 14th, Messrs. P. Huddleston & Co. will sell by auction a quantity of electrical machinery and apparatus, of which particulars are given in our advertisement pages to-day.

Robertson Electric Lamps' Fire Brigade.—On Saturday, March 26th, the prizes won by the above fire brigade in the recent London competition were distributed. A concert was held in the Works' Dining Hall, and was attended by about 1,000 of the employés and their friends. Mr. Hirst, the chairman of the company, occupied the chair, and was accompanied by Mrs. Hirst and several friends. Among other visitors were Captain Miller, the chief of the Leyton Fire Brigade, and representatives of several of the brigades taking part in the competition. The Robertson Fire Brigade are now holders of the Championship Cup for London for the best aggregate points in the whole of the competition, and also the Challenge Cup for the best individual performance at the competition. One man, F. Goulden, took part and won a prize in every competition in the programme. After the distribution of the prizes, Mr. Wilson, the manager, proposed a vote of thanks to Mr. Hirst for presiding, and this was carried with musical honours.

Pumps for Battersea.—The B.C. has lately placed with Messrs. Mather & Platt, Ltd., an order for a second electrically driven pump for drawing the necessary condensing water from the Thames and lifting it to the tank on the top of the engine house. The pump is of Mather & Platt's high lift turbine type, No. 7 size, capable of delivering a maximum of 100,000 gals. of water per hour, which, however, may be reduced to half that amount when desired. The total head will vary 50 to 60 ft., according to the state of the tide in the river. The pump is driven by an entirely enclosed steel-clad motor of 60 B.H.P., taking current at a pressure of 460 to 520 volts. The contract includes all the piping and valves, both suction and delivery, and the starting and regulating switches, and the whole plant is a duplicate of that supplied by the same firm and put down some time ago.

Trade Announcements.—Messrs. Helps, Wocdfin and Co., of Old King Street, Broadmead, Bristol, have been appointed agents for the West of England and South Wales for Lord Kelvin's electrical instruments and switchgear, as manufactured by Messrs. Kelvin & Jas. White, Ltd., Glasgow.

The offices of Messrs. J. H. Heathman & Co. have been removed to 10, Parson's Green, Fulham, S.W. Owing to the increased demand for their patent ladders, additional buildings for stock and showrooms and factory are to be erected.

The Consolidated Electrical Co., Ltd., have just appointed as agents for Scotland, the Power Appliances Co., of 22, Renfield Street, Glasgow, and for the West of England & South Wales district, Messrs. Drewett & Hood, of 26, Bath Street, Bristol. At both addresses stocks will shortly be kept of the company's various manufactures.

The E. & A.O. Co., Ltd., have taken a set of offices at 1, Temple Street, Birmingham, where they will have a show and stock room under the management of Mr. V. J. Delebecque, and customers in that district should send their inquiries and orders direct to the above offices.

Messrs. Green & Boulding, of 105, Bunhill Row, E.C., have been appointed sole European agents for the Star Brass Manufacturing Co., of Boston, Mass. (makers of the "Star" steam engine indicator and other boiler fittings) and all communications should be addressed to the Bunhill Row address, as the company's late office in Queen Victoria Street is now closed.

Messrs. Christy Bros. & Middleton, electrical engineers, of Chelmsford, announce that, in order to deal with increased business, they have engaged the services of Mr. E. S. Saunders, recently of the British Westinghouse Co., who will represent them in the South and West of England.

Book Notices.—*Calculating Tables.* By Dr. H. Zimmermann; translated from German by L. Descroix. London: Asher and Co. 1904. Price 6s. net. The author points out in the preface that arithmetical calculation, though a laborious task, is indispensable in many cases, as, for example, when the worker is unacquainted with the use of logs, or when he has to deal with large sums of money, requiring not merely close approximation, but absolute accuracy. He claims for his tables that, with practice, calculations can be made by their assistance more rapidly than by any other means. The work consists really of a huge multiplication table, with notes at the foot of each page giving certain powers and roots, areas of circles, reciprocals, logs, &c. Great confidence is expressed in the freedom of the book from errors, and a reward is offered for the detection of such. The principal table contains, on 200 pages, the products of numbers from 1 to 999 with numbers from 1 to 100. To facilitate references, advantage has been taken of various typographical artifices, such as heavy type and thick rules at intervals, and grouping of the horizontal lines. The remaining tables give the factors of odd numbers from 1 to 999, and a number of important constants. Full explanations and examples are given, showing how a great variety of calculations can be quickly made; shortened methods are also given for use where absolute accuracy is not called for. The tables undoubtedly represent the fruits of an immense amount of labour, and will be found useful for certain classes of computations; much practice, however, is indispensable before rapidity can be attained.

Table of Multiplication, Division and Proportion.—By R. H. Smith, M.I.M.E. Westminster: Archibald Constable & Co. 1903. Price 6s. net. This table is mounted on canvas, folding up to $3\frac{3}{4} \times 11\frac{1}{2}$ in., and is ingeniously arranged so that it need never be opened out at full length; one side of the sheet is occupied with explanations, and the other with the table. The scope of the table is from 1 to 100 and from 1 to 160, and the product of any two numbers between these limits can be read off at once. No decimal points appear in

the table; the user is to ignore them until the operations are completed, finally inserting the point in its correct position by making a mental estimate of the order of magnitude of the result. This process, while it presents no difficulties to a ready intellect, probably offers too many opportunities of error to be trustworthy in the hands of the unskilled operator. The instructions for the use of the table are given diagrammatically where this is possible, and the methods of interpolation described are very ingenious. The table is intended for the ready calculation of quantities and costs, invoice prices, interests and discounts, wages and wage premiums, &c., besides ordinary operations of multiplication and division. Given sufficient practice to become adept in its use, no doubt it will meet the needs of many who prefer or are obliged to perform their calculations arithmetically.

Oil Engines. By W. A. Tookey. London: Merritt & Hatcher. Price 1s. net. This little book deals first with the advantages and general principles of oil engines; secondly, with the special features of the leading designs, for the guidance of the purchaser; thirdly, with the erection of the engines, for the use of the workman; and, lastly, with the starting, running, and attendance on them. An appendix gives brief descriptions of the various designs of oil engines on the market. The work is essentially practical, and is written from a common-sense point of view. Numerous sage hints to intending buyers are given, regarding the exact meanings and values of various technical terms, such as "Test Brake H.P.," as distinguished from "Maximum Working Brake H.P.," &c. The instructions for erection are evidently derived from experience, and the same is true of the hints to attendants. Nothing seems to escape attention; for example, even the effect of rarefaction of the air at high altitudes in diminishing the output of oil engines is pointed out, and the danger of leaving oily waste about is mentioned. We recommend the book to purchasers, erectors, and attendants, with confidence that they will find it extremely useful.

The Central. London: Unwin Bros. March, 1904. The second number of this young magazine has come to hand, and is in every way worthy to compare with its predecessor. The frontispiece is a portrait of Prof. O. Henrici, who is regarded by all old Central men with real affection and esteem. An illustrated description of the engineering laboratories and workshops, and of the course of study in surveying, is given by Profs. W. C. Unwin and A. G. Ashcroft, and an excellent sketch of the huge electrical power supply of Montreal by J. M. Donaldson, in addition to other interesting articles. The editors, Dr. E. F. Armstrong and Mr. M. Solomon, announce that two more numbers will be issued this year, in June and November respectively.

The Engineer's Year-Book. By H. R. Kempe, A.M.Inst.C.E. London: Crosby Lockwood. 1904. This well-known work is now in its eleventh year of publication, and hardly needs recommendation. We note that in the new edition, amongst the usual amendments and additions, a section on tramways has been included, from the pen of Mr. W. H. Smith, and the work of the Standards Committee has also been utilised. The number of pages has now reached 900. Having regard to the enormous amount of practical information contained in the volume, and the large variety of subjects dealt with, the year-book should be an indispensable desk companion to an engineer.

Logarithms for Beginners. By C. N. Pickworth. London: Whittaker & Co. 1904. Price 1s. The author of this handbook, having produced an excellent manual on the slide rule, has turned his attention to the underlying principles, which he finds somewhat inadequately treated in text books on algebra and trigonometry. These principles are first very clearly explained, with numerous illustrative examples, and without unnecessary digressions into the mathematical theory of indices and logarithms; the practical use of logarithms and of logarithmic tables is then fully dealt with and exemplified. Tables of four-figure logs and anti-logs are given at the end of the book. We have nothing but commendation for the work, which will certainly be of great use to the student.

"Manipulations et Etudes Electrotechniques," by L. Barbillion. Paris: Ch. Dunod. Fr. 12 50.

"Some Features of American Education," by Robt. Blair. Dublin: Department of Agriculture and Techuical Instruction.

"Transactions of the Institute of Marine Engineers." Vol. XV., Session 1903-4. London: The Institute.

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LIGHTING AND POWER NOTES.

Birmingham.—The report of the Electric Supply Committee, to be presented at a special meeting of the City Council on the 12th inst., deals with the proposed extension of the Corporation's electric light undertaking. It is pointed out that on July 31st, 1901, the Electric Supply Committee submitted to the Council a scheme for a generating station with an ultimate capacity of 10,000 KW., at an estimated cost of £239,220; but this scheme has not been proceeded with, and only a portion of the loan has been spent or borrowed. The unexpended portion of the loan is £167,776. Under the Corporation Act, 1903, the Council obtained powers to work tramways in the city, subject to the existing leases; and in May last it was decided to proceed with the electrification of the whole of the tramways, the leases of which expire in 1906. The length of the tramways is about 24½ miles. The leases of the remaining tramways, having a length of about nine miles, expire in 1911. The present stations are taxed to their utmost capacity in times of top load, and no considerable extension of them is possible, and the Committee is convinced that a larger scheme than that submitted to the Council in 1901 is not only necessary, but will prove in the end to be more economical. The total kilowatt capacity of the existing stations is 5,260. The estimated cost of erecting and equipping the station to a capacity of 22,000 KW. is £510,000, including £130,000, the estimated cost of the buildings. For the present the Committee believes that the needs of the department will be met by the equipment of the station to a capacity of 8,500 KW. —viz., 3,500 for private lighting, 3,500 for tramway purposes, and 1,500 spare plant, at a cost of £260,620. Six sub-stations will ultimately be necessary, including the existing station at Parker Street, where certain alterations will be required. The cost of the sub-stations and equipment is estimated at £132,200. For the first equipment it is proposed to install four of such stations, one of them being the Parker Street station, at a total estimated cost of £55,186. The estimated cost of the first equipment is as follows:—Main generating station: Buildings, &c., £106,000; boiler-house plant, £29,947; engine-house plant, £113,618; circulating water plant, £9,130; workshop equipment, £1,925; total, Summer Lane first equipment, £260,620; sub-stations and first equipment, £55,186; underground cables, £123,336; meters, £2,000; total, £441,142. The Committee recommends that the L.G.B. be asked to cancel their sanction to the previous loan so far as relates to the unexpended portion, amounting to £167,776 14s. 1d., and that the Finance Committee be authorised to apply for the necessary sanction.

Coventry.—The City Council has instructed the engineer to obtain tenders for the pipe work required in connection with the new generating set, and the crane required. The Council is taking steps to apply for sanction to a loan of £31,575 for extensions.

Devizes.—The T.C. has appointed a special committee with power to call in expert advice to further consider the E.L. question.

Dorking.—The Dorking Electricity Supply Co., who have leased the U.C.'s prov. order, last week completed laying their mains, and are now in a position to supply the town with electricity. The charge is at the rate of 7d. per unit for the first hour, and 4d. per unit afterwards, with an alternative of 6d. per unit for any quantity. Prepayment meters of either 1d. or 1s. type can be installed, arranged to supply at 7d. per unit. For power and heating purposes the charge is 4d. per unit for the first hour per day, and 1½d. after, or a flat rate of 2½d. The wiring of premises is undertaken, and may be paid for in cash, or payment over a period of years; a system of "free wiring" is also largely used. The company also hire out motors and arc lamps, radiators, cookers, &c. The generating plant consists of Babcock boilers, Belliss engines and Parker dynamos, while the storage battery contains some 260 cells.

Dublin.—The report of the Electric Lighting Committee on the tests of the generating plant at the Pigeon House generating station has been issued. It embodies Mr. Hammond's report dealing with the official tests conducted from February 27th to March 11th last. From this it appears that the—

"1. Principal points in which the generating plant complies with the specification—Capacity of engines, parallel running, absence of nuisance outside the works, ability to run condensing and non-condensing, capability of working with superheated steam, cyclic variation, hand adjustment of governors, steady running, capacity of alternators, insulation resistances, temperature rise of alternators, self-regulation of alternators, excitation watts of Nos. [?], capacity of exciter, temperature rise of exciter, freedom from sparking.

"2. Principal points in which the generating plant does not comply with the specification—Range of governors, momentary variation of governors, excitation watts of No. 4, regulating resistances."

In spite of these excellent results, many points of detail are unsatisfactory—such as oil consumption, guides running hot, larger engines have considerable rock and hammering of dashpots is very marked, the wipers on the valve gear are unduly worn, engines are not free from knock; other points are undue wear in bearings, oil creeping, steam and water leakages. As a result of these defects Mr. Hammond was compelled to reject the engines, and so informed the Committee.

The contract for the generating plant was held by the General Electric Co., with Messrs. Duncan, Stewart & Co., Glasgow, as sub-contractors for the engines. As a result of a conference between the Committee, Mr. Hammond, and the managing director of the G.E. Co., the latter has agreed to undertake the reconstruction of the defective engines, and, if necessary, to replace them entirely. They are further prepared to erect for the coming winter a new 1,000 or 1,500-KW. set for use during the reconstruction of the present plant, the new plant to be taken over by the Corporation when required, but payment to be deferred for two years from the date of the engineer's certificate of completion. The price to be based on competitive rates to the satisfaction of the Corporation and the L.G.B., and to be fixed before any work is done under the agreement, except urgent work. If the supply does not call for the additional plant, no charge is to be made for it.

The Committee recommends the Council to agree to this offer, as the available capacity (2,000 KW.) of the works will probably be exceeded next winter.

Dover.—The T.C. has applied to the L.G.B. for a loan of £11,260 for E.L. purposes. It is proposed to provide an additional 400-KW. Parsons turbo-alternator, and auxiliary plant. Arrangements have also been made for a loan of £150,000 for the purchase of the undertaking on May 6th.

Glasgow.—Draft specifications have been prepared and submitted to the Trustees of the Clyde Navigation for the electrical cranes for the outer basin of Clydebank Dock.

The dispute between the Caledonian Railway Co. and the Corporation tramways and electricity departments in regard to the question of the supply of water from the canal for Port Dundas and Pinkston stations for condensing purposes is practically settled.

A B. of T. inquiry was to be held into the orders for electric lighting for Kilpatrick and Vale of Leven in Dumbartonshire, and Shettleston and Bothwell in Lanarkshire. The orders are promoted by the Clyde Valley Electric Power Co.

Gloucester.—The T.C. has fixed the price of energy for the tramways at 1¼d. per unit, and for lighting the tramway depôt at 2d. per unit.

Hexham.—The application of Mr. James Hall, of Dilston, for the prov. order for the electric lighting of Hexham and district has been granted by the B. of T.

Halifax.—It has been decided to lay a new feeder from the Electricity Works to Wards End, length 1,029 yds., at an estimated cost of £811 10s.

Heckmondwike.—At a special meeting of the E.L Committee, a recommendation to expend a further sum of £5,000 on much needed extensions to the electrical undertaking, was referred back to the Committee.

Leigh.—Mr. G. F. Metzger, who has been called in to give expert advice to the Corporation with regard to its electricity undertaking, recommends a complete change of existing conditions at a cost of £6,500, or, as an alternative, that new works should be erected on a different site. Mr. Metzger reports the undertaking to be in a very unsatisfactory condition; "it appears to have been designed as if extensions would never be required." They are now urgently necessary.

Liverpool.—The annual report of the lighting department of Liverpool, prepared by Mr. C. R. Bellamy, A.M.I.C.E., shows that Liverpool is now lighted by 17,720 public lamps, of which 13,918 are street lamps, including 13,279 incandescent gas, 185 10-ampere electric arc, and 454 flat flame gas. The total mileage of roads lighted at the end of December, 1903, was 436¾ miles, of which 4½ miles were lighted by electricity. The number of electric meters tested was 2,770, the testing fees of which amounted to £138 15s. The electrical department was also debited with £220 per annum for maintenance.

London.—WANDSWORTH.—The B.C. has decided to ask the County of London Electric Supply Co. to reduce the charge for energy for lighting to a flat rate of 4½d. per unit.

FULHAM.—The B.C. has agreed to take a lease of the engine room of the Granville Theatre and fit it up as a sub-station at an estimated cost of £950.

BERMONDSEY.—The B.C. has sanctioned the expenditure of £1,115 for further extensions. The Electricity Committee reported that at present a charge of £20 a year is made for each arc lamp, including incandescent fittings, and for incandescent lamps, £4 for two 16-C.P.; £5 10s. for three 16-C.P.; £6 10s. for four 16-C.P., inclusive of maintenance. These charges worked out at 2·49d. per unit, or deducting maintenance, 2·20d, whereas the actual cost to the undertaking was 3·2d. per unit. The Committee recommended that in future the charge for street lighting be 3d. per unit, exclusive of cost of maintenance. This was agreed to.

BETHNAL GREEN.—The B.C. has resolved to supply electric light and to erect a dust destructor, in connection with the generating station, the total expenditure involved being about £200,000.

Macclesfield.—At a special meeting of the E.L. Committee, held for the purpose of arriving at a decision in regard to an electrical scheme for the borough, an amendment that the Council should advertise for tenders to lease the prov. order was carried by 7 votes to 5.

Malton.—The U.D.C. has approved the plans of the electricity station proposed to be erected by the Northern Counties Electricity Supply Co.

Morecambe.—The T.C. has entered into an agreement with the General Electric Co., Ltd., for the supply of motors for hiring-out purposes.

Retford.—At the meeting of the T.C. on March 25th, the town clerk reported that the B. of T. had intimated that they would not permit the E.L. order, which had expired, to be extended much longer. The Council decided to ask for further time, arrangements having been made with the Derbyshire and Notts. Electric Power Co., to bring a supply of electricity to the boundary of the borough, where the Council will take control and distribute it.

Runcorn.—Negotiations are in progress between the Mersey Electrical Co. and the U.D.C. for the acquirement of the Runcorn electric lighting order, which has expired next June. It is proposed to lay out electric tramways in connection with the scheme.

Salford.—The scheme for extending the electricity undertaking includes estimated expenditure on cable works in certain streets, mains, and private service terminals, new motors, and a new workshop. Energy is to be supplied in the near future to fulfil a tender for supplying light and power to the Manchester Ship Canal Co. The existing borrowing powers of the Corporation (extending to £397,000) are not yet all exhausted, and the balance remaining (£36,000) will be available, in part, for the new requirements. The total capital expenditure of Salford electricity undertaking, as shown by the amounts of loans previously sanctioned by the L.G.B. is £566,814. The Board's inspector, at the inquiry held recently, expressed some dissatisfaction at not getting the figures in fuller detail, and the inspector said he must take it that the estimated requirement of £25,000 was a mere assumption. The L.G.B. required to know everything connected with the scheme, and how the estimate was arrived at. The Corporation stated that the number of consumers could hardly be arrived at, but they would be able to supply up to 500.

Salisbury.—The local E.L. company offered to supply energy for lighting the Workhouse at 4d. per unit, with £193 for installing 179 lamps. The offer, however, was refused by the Board of Guardians.

Shawinigan Falls.—The Shawinigan Falls Water Power Co. has recently completed a power transmission line to Sorel. The energy is transmitted to Joliette, Quebec, at a pressure of 50,000 volts, and there transformed down to 12,500 volts, the line then crossing the St. Lawrence River. Aluminium cable has been used throughout. A second line to Montreal, with a capacity of 10,000 H.P., is to be erected.—*Industrial Canada.*

Southampton.—The Electricity Committee has reduced the price of energy to the Tramways Committee to 2½d. per unit in lieu of 2¾d. per unit; the charge for private lighting was reduced to a flat rate of 4¼d. per unit to consumers on the 200-volt circuit.

Spain.—Application has been made for a concession for the public and private electric lighting of the town of Bétera.

Todmorden.—The L.G.B. has written sanctioning the borrowing of £20,000 for the purposes of electric lighting, and £6,000 for a refuse destructor.

Torquay.—The Electrical Committee recommends with regard to the proposed new electrical station, that the Council revert to the first site close to the refuse destructor instead of that in the Lymington Road. The cost would thus be reduced for the building to £8,471, as compared with £11,105. A third scheme was put forward combining the advantage of both, and to cost £9,005, as against £11,105. Subsequently it was agreed to refer the whole subject back to enable the Committee to give its consideration to all three schemes, and present a detailed report.

Wilmslow and Alderley.—The B. of T. has sanctioned the Wilmslow scheme of the Wilmslow and Alderley Edge Electric Lighting Co. The company propose to erect a new generating station and lay cables along the principal thoroughfares. The Urban Council proposed to introduce electric lighting in the first instance, but the ratepayers petitioned against it, and the scheme was abandoned.

Wimbledon.—The U.D.C. has applied to the L.G.B. for a loan of £6,600 for the provision of E.L. mains, transformers, sub-stations, meters, &c.

Wisbech.—A ratepayers' meeting has been held in opposition to the resolution recently passed by the T.C. to accept the terms of the National Electrical Construction Co. for lighting the town.

TRAMWAY AND RAILWAY NOTES.

Ashton.—The Assessment Committee has reduced the assessment of the plant of the South Lancashire Tramways Co. from £500 to £494, and that of the rails, poles and plant from £494 to £360.

Belgium.—The Brussels Tramway Co. has now converted its lines almost entirely to the overhead trolley system, a few short sections being worked on the underground conduit method and by means of steam cars. During 1903 the receipts largely increased and the net profits exceeded £96,000, which sum has been mostly paid away as dividend on the various classes of shares. At present the company has an equipment of 849 motor-cars and trailers. In the case of the Antwerp tramways, which have been in course of transformation to the overhead trolley system, the last horse traction line was discontinued in November of 1903, so that the scheme of conversion has been completed two years before the date stipulated in the concession. As it was impossible to finish the power station as promptly, the supply of energy has been furnished by the local electric lighting company, so as to obviate any delay. The net profits of the tramway company for 1903 amount to £35,700, which is to be divided among the different classes of shareholders.

Berlin.—The report for 1903 of the Berlin Grand Tramways Co., which has a share capital of £4,289,250, and whose entire network is now worked by electric cars, shows net profits amount-

ing to £412,227 as compared with £367,776 in 1902; and a dividend has been declared at the rate of 8 per cent. as against 7½ per cent. in the previous year. Almost the whole length of 304 miles of track are operated on the overhead trolley system, only 1·86 mile being arranged on the underground conduit method in order to comply with the requirements of the Government and local authorities. The cost of maintaining this short length of conduit line was heavy, the outlay being no less than £4,128 during the year. The ratio of working expenses to gross receipts for the entire system amounted to 53·88 per cent. as compared with 55·41 per cent. in 1902. The report states that in order to secure economy in the consumption of current, a number of meters have been purchased and placed in the motor-cars, and although the experiment has not yet been completed, it promises to yield favourable results. During the working year a total of 13 persons were killed, 1,397 were slightly injured, and 184 severely injured.

Blackpool.—The double line of tramways at Blackpool has been officially inspected, and is now open for traffic. The new line extends from the Central Pier to Alexandra Road, on the north side of the Victoria Pier, South Shore, completing the double line throughout the length of the Promenade.

Cheltenham.—The Light Railway Commissioners, who held an inquiry lately in Cheltenham, have sanctioned the laying of single line in the narrow part of High Street between Bath Road and Cambray Place. Messrs. Dodd & Dodd, of Birmingham, prepared the various plans and gave evidence at the inquiry.

Glasgow.—The running of the T.C. cars over the part of the Paisley system, which has just been finished, has been delayed meantime.

Hyde and Stalybridge.—The erection of an electrical sub-station has been begun at Hyde. The central generating station on the boundary between Dukinfield and Stalybridge is nearly completed, and it is expected that the tramlines will be ready for traffic about a fortnight hence, as regards these two boroughs; between Stalybridge and Hyde, cars cannot be run before midsummer.

Lancaster.—From statements made at the "budget" meeting of the T.C. on March 30th, it appears that the total loss on the electric trams up to March 31st is £4,977 14s. It is proposed to meet £2,101 9s. this year, and leave £2,876 to pay next year. Alderman Smith, the chairman of the Committee, explained that the Corporation had borrowed £51,000 for tramway system, but had only spent £29,000. The other routes had been delayed, and in consequence they had to meet the interest and redemption on the whole capital. This accounted for the deficit, which was equal to a rate of 2¾d. in the £, a proportion of the 6d. increase in the rates.

L.C.C.—At last week's Council meeting Lord Welby said the estimate of receipts for the year from the Council's tramways was £578,500, and up to March 19th the Highways Committee reported that the receipts had been £498,363. If they took £17,000 as a fair estimate for the remaining 12 days of the financial year, the receipts would amount to £515,363. That would be £63,137 below the estimated receipts. He promised to explain in his annual financial statement how it was proposed to make up the deficiency.

Liverpool.—The Tramways Committee has recommended that the City Council sanction the borrowing of £75,000 for the purchase of land in Hatton Garden and the erection of tramway premises thereon.

Liverpool—Southport Electric Railway.—On April 5th this electric railway was opened for passenger traffic. Being Easter Tuesday a large number of travellers passed between the two towns. The first electric train left Southport at 10.15 a.m., and the first from Liverpool was at 11.30 a.m. The trains ran successfully throughout the day. Steam trains are also being run, but they will be gradually reduced to vanishing point.

London United Tramways Extensions.—The line connecting Hammersmith Broadway District Railway with the City *vid* Acton, Ealing, Hanwell, Southall, Hayes, Hillingdon, and Uxbridge Town has now been constructed. On Monday evening a party of the company's officials made an initial trip over the line for the purpose of testing the new works. The car started at eight o'clock from the Chiswick depôt, reaching the old terminus at Southall shortly before nine, and Uxbridge terminus about 9.45, leaving on its return journey at 10. With the completion of the depôt and sub-station at Hayes within the next few weeks, the works will be ready for the official inspection of the Board of Trade, when the line will be opened for public traffic.

Manchester and Salford.—The amalgamation, or "federation" (to use a new term, in this connection) of Manchester and Salford, will, if carried out, have an important bearing on the electricity and tramway undertakings of the city and borough. It has been an open secret for some months past that a movement is on foot for the consolidation of the municipal interests of what is really one great community. This is now taking a more concrete shape. Salford has, till now, been totally opposed to all idea of amalgamation, in the ordinary sense, but the advantages of a unification of interests are so obvious that a modified form of amalgamation, under which the borough would not lose its identity, is being seriously considered. The Council is to be asked to appoint a committee who will inquire into the matter from the ratepayers point of view. It is recognised that at present there is a considerable overlapping in administration which might be avoided. The tramway conveniences both of the city and borough would be improved under one system, and a similar advantage is looked for as regards electricity. In other directions also, more particularly in the matter of public improvements, and communications between one district and another, Salford would benefit largely by federation, whilst retaining its municipal associations. The details of the scheme are understood to have been considered privately, but they have not been allowed to transpire.

Manchester.—Our correspondent writes:—"Electric car fatalities are becoming unpleasantly frequent in Manchester and Salford. Several young children have been killed during the last week or two, through running under or being knocked down by the cars. In the case of a child fatally injured in Stretford Road, it was stated at the inquest that the cradle of the life-guard, instead of receiving the child, pushed it along for some yards, and then passed over it. The car had to be 'jacked up' before the child could be removed. The automatic life-guards now in use, though acknowledged to be the best that have been tried, are not, it would appear, always effective. A similar accident happened to a little girl in Salford."

On Good Friday the new tramline from Cheetham Hill to the Middleton Road entrance to Heaton Park, the newest and most attractive of the public parks of Manchester, was used for the first time. The traffic from the city to Heaton Park during the summer season is very heavy.

Middlesbrough.—At an inquest held here into the death of a four-year old child who was knocked down by an electric car, the evidence given by a spectator was that the car was travelling at seven or eight miles an hour, that the car went off about 30 yards after the child was knocked down, the brake not appearing to act properly. Mr. Fritz Rogers, the tramway company's district manager, said that there was no reliable guard in the market.

Northern Railway of France.—The Northern Railway Co. of France are at present installing a transformer sub-station at the Amiens Railway Station. The direct current supplied by the power house is to be transformed here into single-phase alternating current, and transmitted over a distance of 5 km. to Longueau, where it will be utilised for the lighting of the railway station. The Amiens sub-station will contain two 35-kw. Westinghouse rotary converters, which will be supplied with direct current at 125 volts, and will give out single-phase current at 88 volts, 50 periods. By means of a 30-kw. Westinghouse transformer, the alternating voltage will be raised to 3,500. This transformer is fitted with multiple contacts, by means of which the number of secondary coils can be varied, so that a constant pressure may be maintained at the consumption terminals. This will allow the primary voltage to vary 5 per cent. each way. At the Longueau Railway Station the pressure will be lowered to 115 volts by means of a 28-kw. Westinghouse transformer. All the electrical plant is being supplied by the French Westinghouse Co.

Paisley.—The first and eastern section of the electric tramway system from Hawkhead to Paisley Cross was completed on Monday last week, and the same evening a Glasgow Corporation car traversed the line.

Pemberton.—The U.D.C. has received sanction to borrow £16,155 for the construction of electric tramways.

Safety Precautions on the Berlin Railway.—Among the latest safety precautions which have been introduced on the Berlin elevated and underground electric railway, may be mentioned the installation in the driver's compartment of a short-circuiting switch, so that the current passing along the third rail may be earthed and the fuses blown at the power station, thus rendering the section dead. An alternative means of short-circuiting is afforded by a portable bar which is provided with insulating handles of some length, and which can be placed by the driver across the third and return rails. These devices are only intended for use in the tunnel sections of the railway if it should be necessary for passengers to alight from a train, and proceed to the next station, or to the escape shafts which are being formed between the stations. The tunnels are now lighted from two independent circuits at intervals of 52 ft., and fire extinguishers are located in them at distances of 325 ft. The hydrants and sandboxes at the stations have been doubled, and each station is directly connected with the fire brigade stations by means of an alarm wire. In addition to these arrangements, the carriages are equipped with portable sandboxes and with other fire extinguishing appliances utilizing water.

South-East Lancashire.—The South Lancashire Tramways Co. are about to lay lines, connecting with the Farnworth Council's tramway system, at the boundary of Farnworth and Little Hulton, along the Worsley and Bolton Roads, to Walkden, as far as the Ellesmere Monument. The lines will be carried from the latter point along the Manchester Road to Swinton, where the Salford car service now terminates.

South Harrow and Ealing Electric Railway.—From the *Daily Telegraph* we gather that on Saturday this electric railway "broke down for the fourth time, and steam locomotion was substituted."

Sunderland.—On the 29th ult., Major Druitt, L.G.B. inspector, held an inquiry at Sunderland as to the application of the Corporation for sanction to effect certain alterations in various routes. That particularly under consideration was the Roker section, in regard to which it was proposed to construct a loop line to ease the traffic, which was very heavy in the summer season,

when many thousands flocked down to the seaside. At present the system consists of a double line from the town to Roker Promenade, and about ¾ mile along the coast. A very large proportion of the passengers go no further than the south end of the Promenade, and to meet this traffic a very large number of cars are run thus far and no further. This necessitates the use of cross-over points, and to some degree causes a delay, as the cars intended to go to the terminus cannot pass until the other cars are shunted on to the townward or up line. To obviate this, it was proposed to take a single line from the down line at Harbour View along Roker Park Road, through St. George's Terrace, and on to Roker Terrace, along which the main line now runs. The Corporation was represented by the town clerk, and Mr. Hans Hamilton, barrister, represented those who objected to the proposals. Mr. J. F. C. Snell, electrical engineer, explained the suggestions. He also stated, in answer to a question by counsel, that on holidays and trip days as many as 80,000 people visited Roker. Mr. Hamilton made alternative suggestions, all of which Mr. Snell declared impracticable. Mr. Hamilton said the objection was that by taking the trams along the streets specified the property would be deteriorated, and it would be most unfair, as many people had gone to these places to escape the noise of the trams. The estate agent of Sir Hedworth Williamson said he had experienced difficulty in selling sites where it was thought the trams would run. Evidence was also given as to the effect on the buildings by the running of the tramways. After hearing various witnesses, Major Druitt said he would report to the Board.

TELEGRAPH AND TELEPHONE NOTES.

Congo Free State.—The telephone and telegraph have just been installed between Kalemte-Temte, Kassongo, Kabambane and Basaka. The systems are working well.

Long-Distance Telephony in Europe.—The total sum expended in establishing and developing the German Imperial telephone service exceeded £12,600,000 at the end of March. Among the long-distance lines, the first place is occupied by that connecting Berlin and Paris, which represents 735 miles. The second is between Berlin and Buda-Pesth, which is 607 miles long; the third joins the German capital and Memel, and is 587 miles; and the fourth, which connects Berlin with Basle, has a length of 572 miles. In addition to these, there are various other German lines which exceed 310 miles, and that which is the most used lies between Berlin and Frankfort-on-the-Maine, this having an average of 485 conversations daily. A considerable extension of the night telephone service between Germany and France has just been made, and also between the former country and Switzerland. In the latter case, the connection between Berlin and Basle is formed by a twin conductor established *vid* Stuttgart, and as experiments have shown the possibility of communicating with other Swiss towns along the same line, the service has been extended to Zurich, Lucerne, Geneva, St. Gall, Berne, Rheinfelden, Winterthur, and other towns. A slight development of the service has also taken place with Belgium.

The Nordenham Cable Works.—The German Emperor, immediately before starting on his Mediterranean tour, paid a visit of inspection to the cable factory of the North German Marine Cable Works Co. at Nordenham, where the final section of the second German Atlantic cable was approaching completion.

Protection of Telephone and Telegraph Wires.—The Prussian Minister of Public Works has issued a new regulation relating to the protection of telegraph and telephone wires from the working of secondary electric railways. It is provided that police protection shall henceforth be enforced in so far as such installations and the safety of the *personnel* might be endangered by the construction and operation of these light electric railways. As dangerous in this connection are to be regarded (1) the coming into contact with the conductors; (2) heating effects, electrolytic effects, and the effects upon life and health which may arise from the use of the earth as the return; and (3) mechanical damage to telegraph or telephone wires during the establishment and working of the railways.

The Steljes Typewriting Telegraph in Italy.—Important demonstrations of the working of this instrument were carried out by Mr. S. de Stefani for the Italian Government and railways and others last week. The first exhibition took place in the presence of the Government and railway officials at Milan, over the line from Milan to Rome and back, 1,600 km. in length; the second demonstration was arranged over the Milan-Brescia telephone line, 200 km. long, and was witnessed by many eminent engineers. Both trials were entirely successful, the instruments acting as efficiently as if they had been directly connected.

Wireless Telegraphy between Heligoland and Hamburg.—The station which was established some time ago at Heligoland by the Navy Board is of German historical interest, from its association with the early experiments of Prof. Braun in the direction of telegraphy without wires. In this connection it is stated that, by the utilisation of the Telefunken system (Slaby-Arco & Braun), messages were simultaneously transmitted during the latter end of March from the Heligoland station to the new steamer *Cap Blanco*, which was lying in Hamburg harbour, and to a Dutch station erected in a shipbuilding yard at Amsterdam. The longest distance covered is about 186 miles, and the telegrams were transmitted with absolute distinctness and free from error.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired
Dominica-Martinique	May 5, 1903	
St. Lucia-Martinique	May 7, 1903	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Cayenne-Pinheiro	Aug. 18, 1903	
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tourane-Amoy	Nov. 10, 1903	
Tarifa-Tangier	Jan. 18, 1904	
St. Jacques-Haiphong	March 7, 1904	
Closed { Nagasaki-Vladivostock	Feb. 15, 1904	
Closed { Port Arthur-Chefu	Feb. 18, 1904	
Landlines.		
Seoul-Masampo	Feb. 13, 1904	
Seoul-Gensan	Feb. 18, 1904	
Anju-Ping-Yang	Feb. 25, 1904	
Ninguta-Vladivostock	March 2, 1904	

CONTRACTS OPEN AND CLOSED.

OPEN.

Acton.—April 12th. The U.D.C. invites tenders for two 200-kw. motor-generators, switchboard, cables, arc lamps, accumulators, and crane. See "Official Notices" March 25th.

Barnes.—April 12th. Batteries, boosters and switchgear for the electricity works. See "Official Notices" March 25th.

Barrow-in-Furness.—April 20th. Condensing plant, electrically-driven pump, &c. See "Official Notices" April 1st.

Belfast.—April 15th. Grease separators and feed heaters for the Electricity Department. See "Official Notices" to-day.

Chili.—June 28th. Electric lighting of the city of Punta Arenas (Straits of Magellan). See this column for February 19th.

Cuba.—April 15th. Tenders are being invited until April 15th by the General Direction of Communications in Havana, for the establishment and working of a telephone exchange in the town Guantanamo. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Communicacionés, Havana.

Edinburgh. — April 23rd. Switchboard extension, piping. See "Official Notices" March 25th.

Epsom.—April 18th. Feeder and distributor cables. See "Official Notices" to-day.

Foot's Cray.—The Council invites offers for the purchase or working of its prov. order. See "Official Notices" March 25th.

Gillingham.—April 11th. Engine and dynamo oil, and electric meters. See "Official Notices" April 1st.

G.W. Railway.—April 26th. Four 200-kw. and ten 400-kw. motor-generators, four cooling towers, cranes, and coal and ash conveying plant, for Park Royal generating station and various sub-stations. See "Official Notices" April 1st.

Grimsby.—April 18th. Electrical installation at the Alderman Dobson Schools. See "Official Notices" April 1st.

India.—April 13th. The East Indian Railway Co. is inviting tenders for electric plant for locomotive workshops, as per specification to be seen at the company's offices in Nicholas Lane, London, E.C.

Italy.—Tenders have just been invited by the Municipal Authorities of Torreimaggiore (province of Foggia) for the concession for the public and private electric lighting of the town.

Italy.—August 18th. Tenders are being invited until August 18th next by the municipal authorities of Amelia (province of Umbria) for the electric lighting of the town.

Lancaster.—April 14th. Permanent way, overhead trolley and other tramway work. See "Official Notices" March 18th.

May-Oatway Installations. — The May-Oatway Fire Appliances, Ltd., invites tenders for a number of installations of its system. See "Official Notices" to-day.

Melbourne.—May 13th. One 750-kw. direct-current steam generator. See "Official Notices" March 18th.

Natal.—May 9th. Electric telpherage system for Bonded Warehouse. See "Official Notices" March 18th.

Partick.—April 12th. One 500-kw. steam dynamo, 75-kw. balancer, and switchboard extensions. See "Official Notices" April 1st.

Rhyl.—April 18th. Carbons, meters, oils for the electricity department. See "Official Notices" April 1st.

Royton and Crompton.—April 30th. Permanent way. See "Official Notices" to-day.

(Continued on page 593.)

THE NEW ELECTRICITY WORKS AND TRAMWAYS OF WEST HAM.

On the 6th of this month the County Borough of West Ham celebrated the formal opening of a new electricity power station, which will rank amongst the largest municipal undertakings in this country.

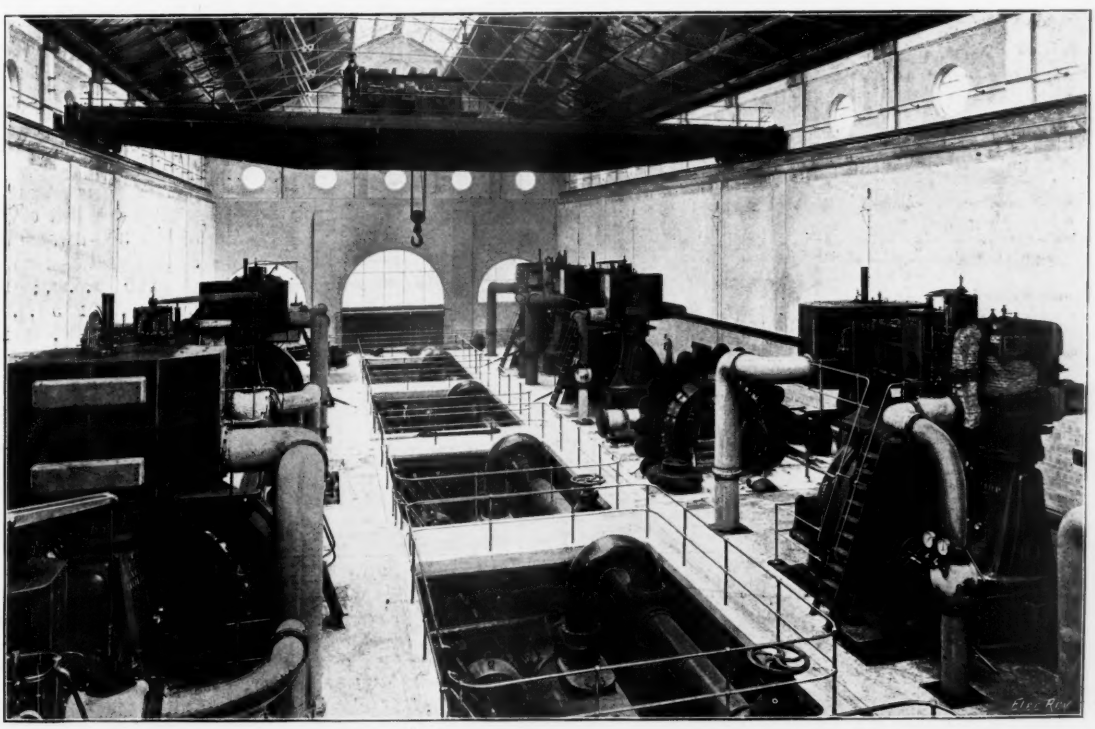
This borough, with a population of close upon 300,000 inhabitants, and embracing an area of 4,707 acres, was granted an electric lighting order in 1892, but nothing definite was done towards providing an electricity supply until November, 1896, when a loan of £50,000 was sanctioned by the Local Government Board for this purpose. The supply was commenced in December, 1898, and the demand increased so rapidly that it was considered advisable to immediately extend the plant. A further loan of £51,000 was authorised, and extensions to the extent of 2,400 KW. were commenced forthwith.

The Corporation was advised on all this work by the borough electrical engineer at that time, Mr. John J. Steinitz, who prepared and carried out the original scheme and the extensions before-mentioned. Mr. Steinitz resigned in July, 1899, to take up an appointment with the Electrical Power Distribution Co., and Mr. James K. Bock, at that time chief assistant, was appointed borough electrical engineer, and has since then advised the Corporation on all electrical work in connection with the lighting and tramway undertakings.

The Corporation in 1898 and 1900 obtained Parliamentary powers to enable it to purchase the North Metropolitan Tramway Co.'s lines within the borough, and also to reconstruct and electrically equip these lines and to construct and equip an additional 7¾ miles of route.

The introduction of electric traction, and the rapid growth in the demand for electricity for lighting purposes, necessitated considerable additions to the generating plant. The existing buildings being fully occupied, it was decided, in the first instance, to erect a new generating station adjoining the original works. On further consideration, and in view of the fact that this would necessitate the purchase of certain cottage property and the diversion of a road, and as the supply of water for condensing purposes was uncertain on this site, the Council, acting on the advice of the borough electrical engineer, Mr. James K. Bock, and the borough engineer, Mr. John G. Morley, decided to erect a new generating station on the site of the old sewage pumping station at Canning Town, and to transfer the plant from the Abbey

James K. Bock, A.M.I.E.E., Borough Electrical Engineer.



General View of Engine Room, from Switchboard Gallery.

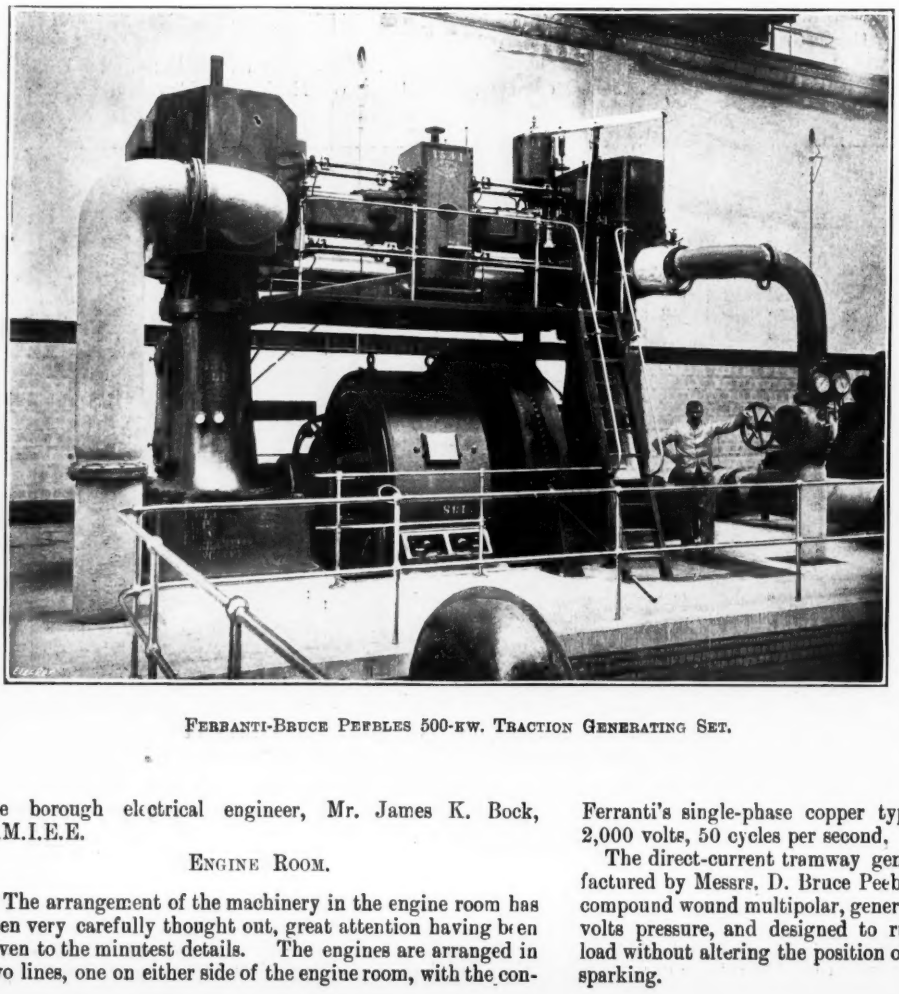
Mills works thereto. This step was taken for reasons of economy in the initial outlay, and the future working of the plant, which were fully explained to and exhaustively inquired into by the Lighting and Tramways Committee at that date. Mr. Bock was instructed to prepare the necessary plans and specifications for the new installation, and Mr. Morley to proceed with the plans and specification for the buildings required.

The system of supply already in use for lighting was single-phase alternating, with a periodicity of 50 cycles per second, and in preparing the new scheme, Mr. Bock gave special consideration to the advisability, or otherwise, of adopting a two or three-phase system of distribution for lighting and traction; but owing to the extent to which the Corporation was already committed to the single-phase system, the advantages of the former systems did not appear sufficient to justify the very heavy additional expenditure which would have been entailed in the conversion. It was consequently decided to retain the single-phase system for lighting purposes, and to install a direct-current supply for traction purposes.

The new power station is situated on the banks of the River Lea, on the site of the old sewage pumping station, the new buildings being erected on a space formerly occupied by settling tanks, the remainder of which are now used as cooling ponds for condensing purposes.

The distance from the old station to the new is about 1¼ miles, and consequently the work of changing over was attended with many difficulties. The work was facilitated by the fact that, although some trouble was at first experienced in synchronising the two stations, they now work perfectly in parallel—the interchange of current being scarcely perceptible.

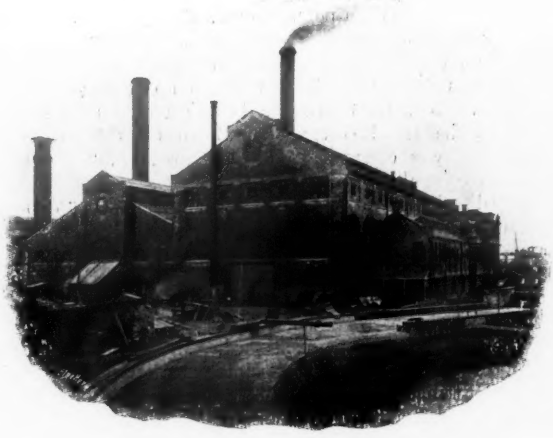
The whole of the machinery has been built and installed, and the arrangement of the same carried out to the specification and designs and under the personal supervision of the borough electrical engineer, Mr. James K. Bock, A.M.I.E.E.



Ferranti-Bruce Peebles 500-kw. Traction Generating Set.

Engine Room.

The arrangement of the machinery in the engine room has been very carefully thought out, great attention having been given to the minutest details. The engines are arranged in two lines, one on either side of the engine room, with the condensers and air pumps in a capacious open trench in the centre and below the floor level. The switchboard gallery is erected at one end of the room at about 15 ft. above the floor level, with an office for the assistant-in-charge opening off one end, and an opening at the opposite end from which an iron stairway gives access to a raised platform running along the end of the boiler house. The assistant-in-charge consequently has the whole system under easy supervision. Underneath the switchboard gallery and on the engine floor level is a space reserved for four Ferranti rectifiers and the traction negative and differential boosters. Beneath this space in the basement are placed four centrifugal pumps which supply the circulating water to the condensers.



Exterior of Works.

A Carrick & Ritchie travelling crane, driven by an electric motor, and capable of lifting and carrying 30 tons, spans the engine room. Space has been left to erect three additional generators of 2,000 H.P. or more each, as required.

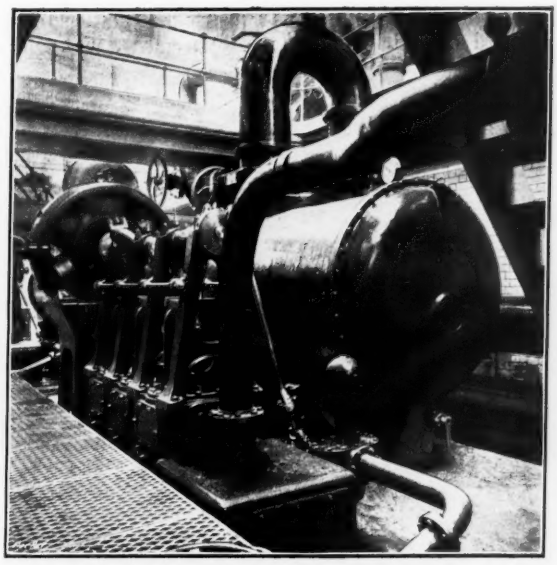
The generators at present installed consist of two 300-kw. engines and alternators running at 250 r.p.m.; two 600-kw. at 225 r.p.m.; two 1,200 kw. at 250 r.p.m.; and three 500-kw. continuous current traction generators at 175 r.p.m.

The engines have all been manufactured by Messrs. Ferranti, Ltd., Hollinwood, and are cross-compound, vertical, condensing, fitted with this firm's well-known patent valve gear and grid valves. The alternators are of Ferranti's single-phase copper type, generating current at 2,000 volts, 50 cycles per second.

The direct-current tramway generators have been manufactured by Messrs. D. Bruce Peebles & Co., Leith, and are compound wound multipolar, generating current at 500—550 volts pressure, and designed to run from no-load to full-load without altering the position of the brushes and without sparking.

Condensing Arrangements.

The condensing plant has all been supplied and manufactured by Messrs. W. H. Allen, Son & Co., of Bedford. The air and circulating pumps for the new plant are electrically driven by means of direct-current 500-volt motors.



Condensing Plant.

No gear is used, the motor armatures being connected direct to the pump shafts. The plant consists of :—

Four surface condensers, of 4,000 sq. ft. cooling surface, each fitted with Edwards type three-throw air pumps with auxiliary force pump.

Four 15-in. electrically-driven centrifugal circulating pumps.

Two surface condensers, of 2,000 sq. ft. cooling surface, fitted with combined air and circulating pumps, driven direct by compound steam engines.

The air pumps on the large condenser are driven direct by 15-h.p. shunt-wound 500-volt direct-current motors. These pumps discharge into a cast-iron tank fitted to each condenser, from which an auxiliary force pump, driven off the air pump crank-shaft, discharges the greasy water to a Harris-Anderson purifier situated outside the engine room. This purifier separates the oil from the water, after which the pure water runs direct into the boiler feed tank. The purifier is capable of dealing with from 1,000 to 1,600 gallons of water per hour, and is entirely self-regulating. The principle of this plant consists in treating the greasy water with certain definite quantities of carbonate of soda and sulphate of alumina. When thus treated the oil and the precipitate formed separate out into flake-like particles, which are easily arrested by the filtering medium used —namely, wood wool. The only attention necessary is that required to reverse the flow of water through the filter once or twice daily, in order to remove the accumulation of greasy sludge from the filtering medium, and to re-charge the chemical tanks. The cost of treating the water is about ¼d. per 1,000 gallons, and the results are extremely satisfactory, there being absolutely no perceptible trace of oil in the water after treatment.

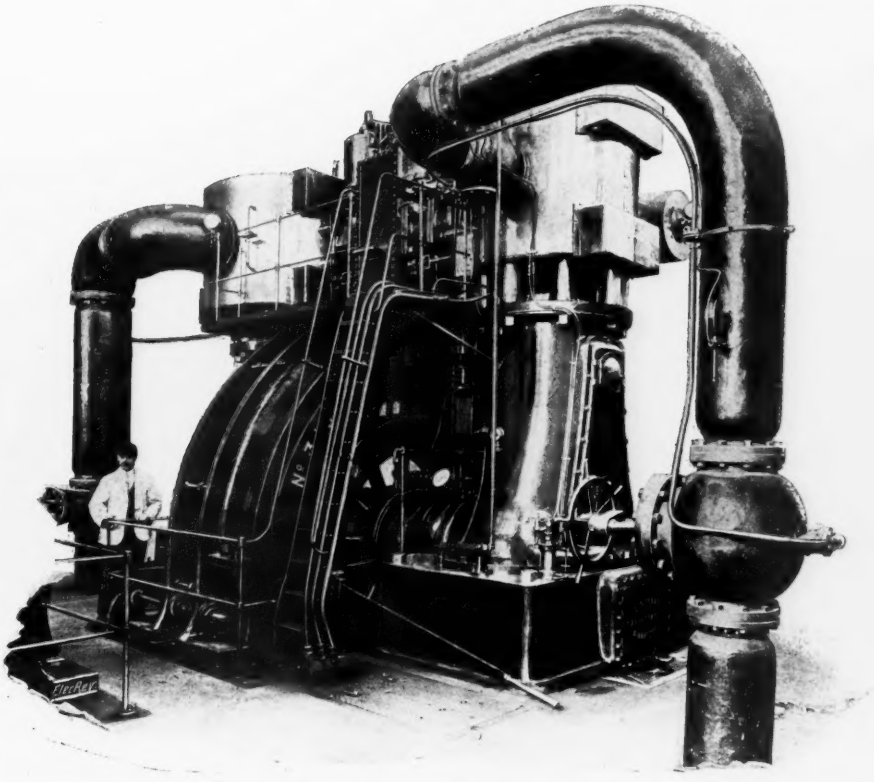
The circulating water is taken from the cooling ponds before mentioned. A pipe, 3 ft. in diameter, is laid from the channel into which all the ponds drain, to a suction tank outside the end wall of the engine room. Four 15-in. centrifugal pumps, direct coupled to 15-b.h.p. motors, take the water from this tank, each pump having an independent suction pipe. These pumps are all below the level of the water in the suction tank, so that there is no difficulty in flooding them. The centrifugal pumps discharge into two 20-in. mains, each of which supplies two of the large condensers. The steam pumps have independent suction pipes.

The circulating water after passing through the condensers is discharged through two 20-in. pipes over a weir, at the end of the cooling ponds opposite the channel from which the water is drawn. These tanks form ideal cooling ponds, being divided into a series of basins. Each consecutive basin in a series is connected to the adjoining one by a hole at the bottom of the division, so that the cooler water from each flows into the next tank. The tanks can be filled at high tide from the River Lea, and there is also a supply available to them from an artesian well.

Boiler House.

The whole boiler house equipment, with the exception of the fans and engines, has been supplied and erected by Messrs. Babcock & Wilcox, to the designs and specification of Mr. Bock, the fans and engines being supplied by Messrs W. H. Allen, Son & Co., of Bedford.

The boiler house is designed to contain 22 boilers, 17 of which are at present installed, the boilers being arranged in two rows with a roomy firing floor in the centre, coal



Ferranti 1,200-kw. Steam Alternator.

bunkers overhead, and an ash tunnel underground. The installation is divided into four self-contained units, each unit consisting of a Green economiser, with 480 tubes and

scrapers driven by a 3-H.P. direct current motor, 60-in. Sirocco fan driven by a 60-H.P. compound Allen engine, battery of boilers, and flues, pumps, &c. Two chimneys have been erected, one for each side of the boiler house. These chimneys are 125 ft. high × 9 ft. 6 in., and 7 ft. 6 in. internal diameter, respectively, and are constructed of steel, self-supported, and lined with fire-brick throughout. Induced or natural draught can be used as required.

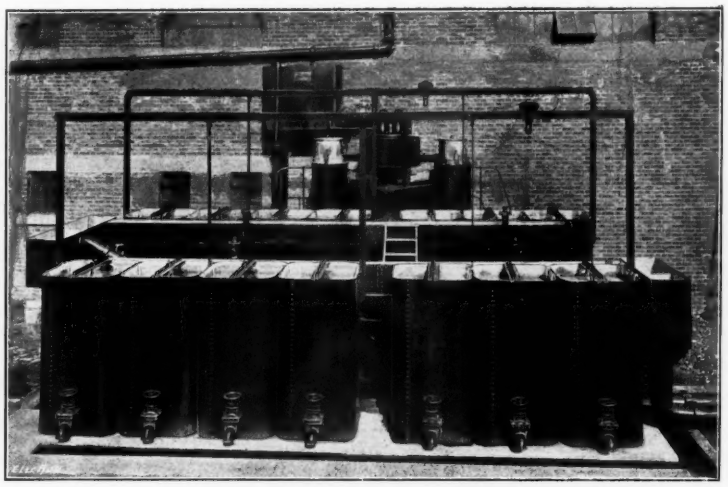
The boilers are of the Babcock & Wilcox water-tube type, with a heating surface of 4,896 sq. ft. and a grate area of 76 sq. ft. each. They contain 420 tubes, 4 in. internal diameter each, and are fitted with this firm's superheater, fixed under the steam drums, which will raise the temperature of the steam 100° F. Steam is generated at 150 lbs. pressure; 13 of the boilers are hand-fired, and the remaining four are fitted with chain-grate stokers. A purifier is fitted to each boiler as an additional safeguard, to arrest any particles of solid matter or oil which might chance to escape the softening and purifying plant.

The ashes from the fire-bars drop into a sloping fire-brick lined chamber, from which they are discharged into trucks in the ash tunnel underneath the firing floor. The ash tunnel is open at either end, and the ashes may be picked up by the Temperley coal transporter and delivered into carts or barges as required.

Overhead bunkers are provided capable of holding 1,600 tons of coal, from which coal is discharged into the chain grate hoppers, or on to the floor, as required, by means of travelling, weighing and swivelling shoots. The coal used is Welsh washed peas on the hand fires, and washed nuts on the chain grates. Coal is delivered into the bunkers direct from barges by means of a Temperley transporter driven by a 30-H.P. D.C. motor, the whole operation of lifting, weighing, travelling, and tipping being performed by the crane driver in the motor house.

Interior of Boiler House: Babcock & Wilcox Boilers.

The boiler feed pumps consist of two Hall compound tandem pumps, and two Weir single pumps, each capable of delivering 60,000 lbs. of water per hour, and four Weir single pumps capable of delivering 30,000 lbs. of water per hour each. The pumps are all fixed in a space in the centre of one side of the boiler house, round the feed tank. The feed water is discharged through a Green economiser to the boilers. The exhaust steam from the feed pumps and fan engines discharges through two copper heating coils, composed of 4 in. copper tube 90 ft. long, in the feed tank.



Harris-Anderson Water Purifier.

Steam, Exhaust and Drain Piping.

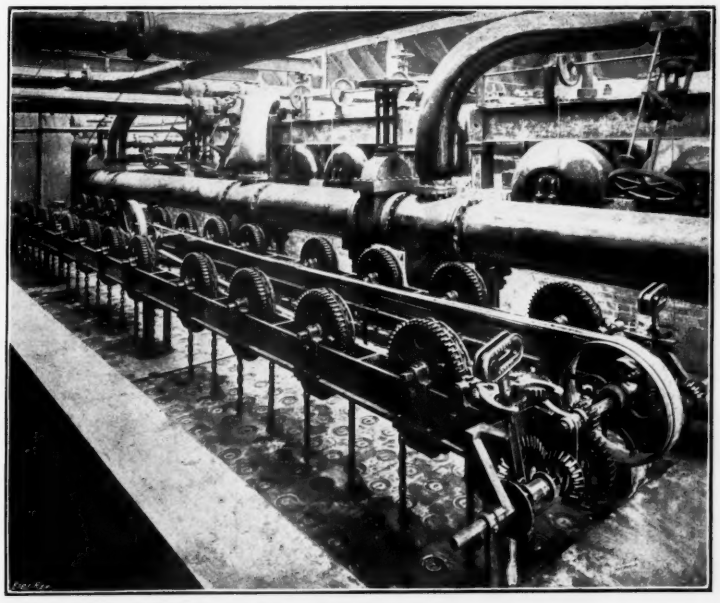
In designing the arrangement of piping Mr. Bock has taken very great pains to ensure as economical working as can possibly be obtained, consistent with reliability. The whole of the pipework down to the minutest details was designed and set out before any contracts were placed. These drawings are very complete, as will be seen from the reproduction at the end of this article.

The steam piping is arranged on the bye-pass system, each engine being coupled direct to a pair of boilers. To prevent any possibility of a rush of water finding its way to the engine cylinders, the pipes are arranged to drop the whole way from the boilers to a separator fixed in the basement 3 ft. below each engine, from which a steam pipe rises vertically to the engine stop valve. A main header of 14 in. internal diameter runs the whole length of the boiler house, and each steam pipe has a branch into the header, so that if desired the boilers can all feed into this common main. This system gives great flexibility and security, with a minimum of piping. Cast-steel pockets are fitted to the header underneath each branch supply pipe. These pockets are fitted with gauge glasses and shut-off cocks, and are connected through Geipel steam traps with bye-pass pipes to a main 4 in. drain, running parallel to and immediately beneath the main header. The main header is divided in the middle by means of four 9-in. expansion bends.

A main 24-in. exhaust pipe is fitted in the condenser pit and runs the whole length of the engine room, each end being connected to an atmospheric discharge pipe, 70 ft. high, fitted with Blake & Knowles automatic relief valves.

Temperley Transporter.

The drain piping is very comprehensive, and consists of three main 4-in. engine room drains, and one 4-in. drain above referred to in the boiler house. The boiler house drain and one engine room drain, to which the separators are connected through Geipel steam traps (both of which convey pure water), return this direct to the feed tank. The remaining drains connected through steam traps to the H.P. and L.P. cylinders respectively, which convey greasy water, discharge into a tank which receives the air pump discharge from the steam condensers, from which the water is delivered to the purifier by means of a small centrifugal motor-driven pump. Every drop of water is, therefore, returned to the feed tank. The feed water piping is arranged in four ring mains, one to each section of the boiler house.



Economiser, Steam Pipes, &c.

A softening plant to deal with 8,000 gallons of water per hour, on the Archbutt-Deeley process, has been installed by Messrs. Mather & Platt, Ltd., of Salford.

Switchgear.

The lighting switchboard has been installed by Messrs. Ferranti, Ltd., and is of their well-known high-pressure cellular type, with three bus-bars. There are 9 300-ampere alternator panels, these being used two in parallel for the 1,200-kw. alternators, and 17 150-ampere circuit panels. The old board from Abbey Mills is being transferred to the new station, and will be built up with the new board.

The traction board, with the boosters, has been supplied by Messrs. The British Thomson-Houston Co., Ltd., Rugby, and is built of slate slabs enamelled and polished in front. The board is fitted with a spare positive bus-bar, and all the switches are arranged to throw over to either bus-bar. There are four 1,000-ampere generator panels fitted with maximum and reverse current circuit breakers, integrating wattmeters, and the necessary switches and instruments; eight feeder panels, B. of T., main, battery, negative and station circuit panels.

A differential booster manufactured by the Lancashire Dynamo & Motor Co. is provided, to be used in the battery circuit; also a 12-kw. negative booster to be used for boosting on one of the longest negative returns.

An auxiliary board to supply the station motors and lighting, made by Messrs. Geipel & Lange, has been fitted and is fed from the station circuit panel.

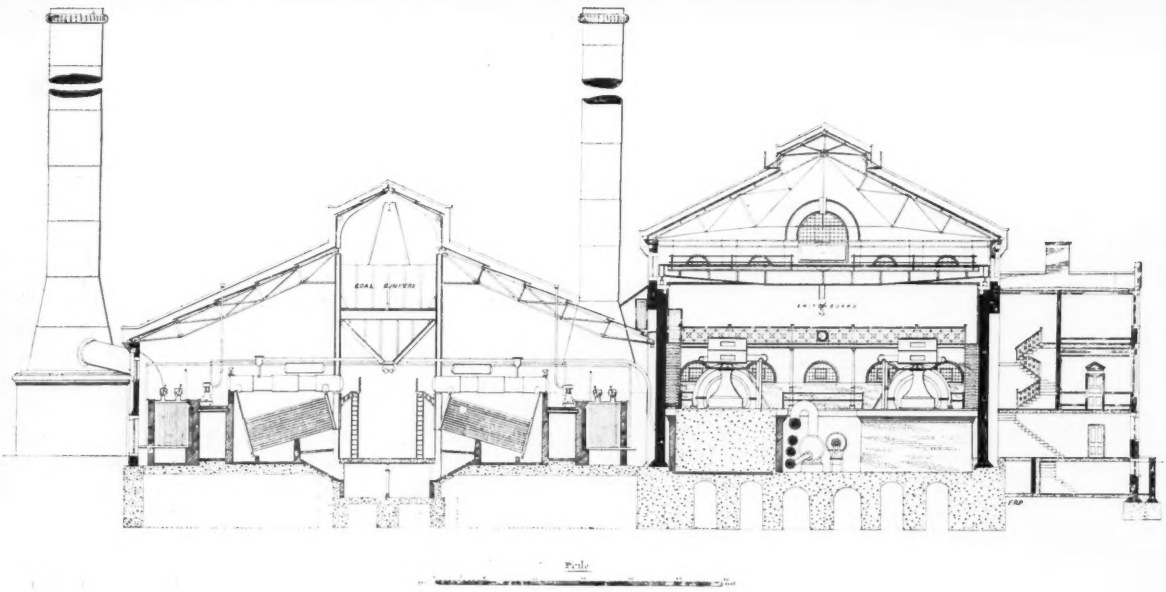
A battery having an output of 200 amperes at 500 volts for four hours has been supplied by the Tudor Accumulator Co. This battery will be used for a great variety of purposes. Its principal function will be to ensure the supply to the station motors, and the street and station lighting, which are supplied from the switchboard in such a way that any failure or fluctuation in current supply to the main board will not affect these circuits.

Distribution.

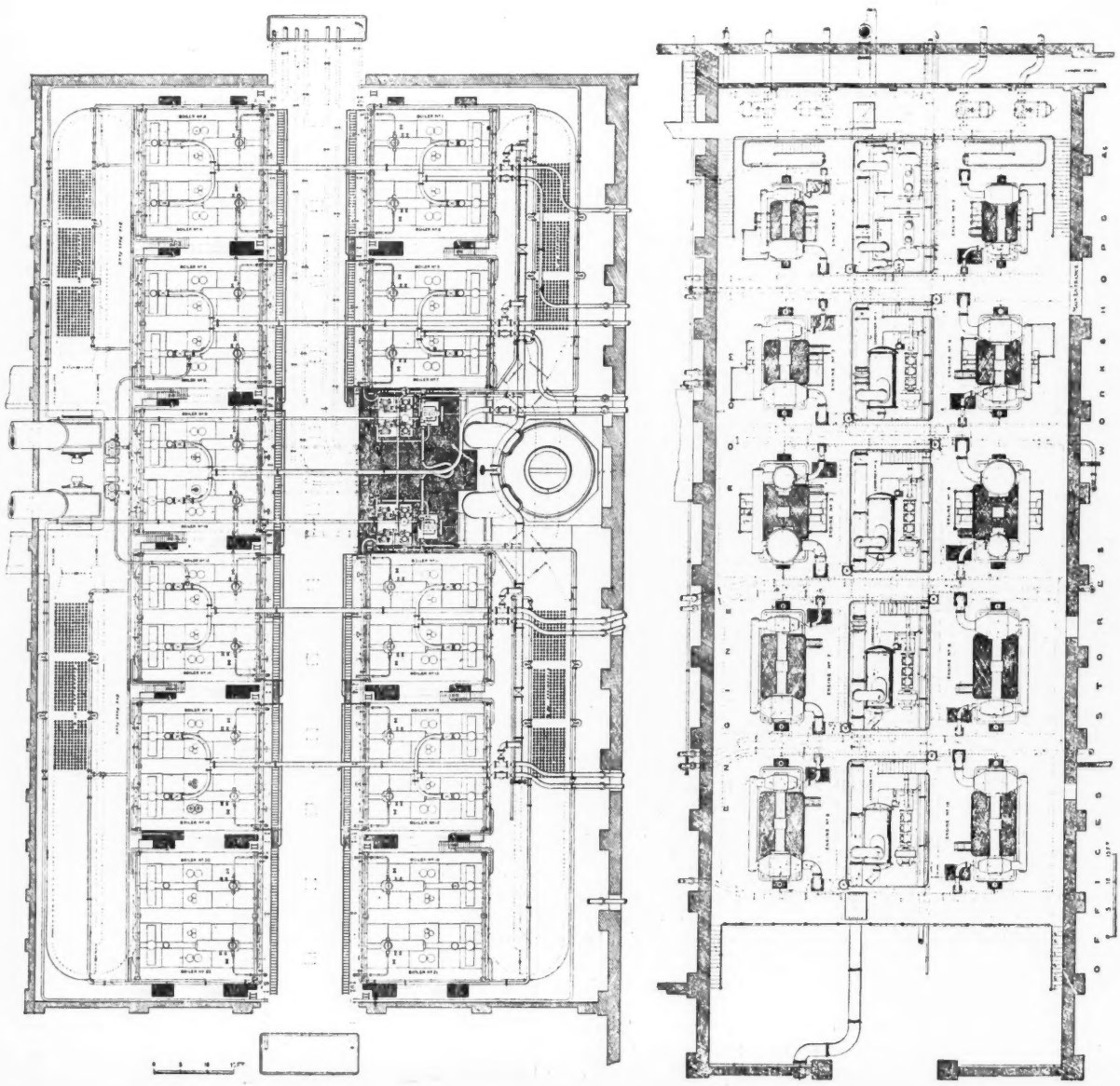
The system of supply for lighting is high-pressure single-phase at 50 cycles per second, with 100 and 200-volt low-pressure distributing networks. All high-pressure cables are concentric paper-insulated, lead-covered, drawn into Albion 3-in. earthenware conduits fitted with Stanford joints.

Sub-stations are chiefly used, which are divided into two sections, one containing the transformers and the other the switchgear, with an iron door between. Ferranti switchgear is fitted, and only concentric cables are used in making connections. The chambers are as safe as it is possible to make sub-stations, and, together with the transformer tanks and switch-boxes, are maintained in excellent condition. No disconnecting boxes are used in any of the high-pressure cables, nor are these broken anywhere excepting in transforming chambers. The original mains were broken every quarter of a mile by plug switch disconnecting boxes, but it was] found

Mather & Platt Water Softener.



Cross Sectional Elevation of New Generating Station.



Plans of Boiler House and Engine Room.

hat the only breakdowns that ever occurred in the mains were caused by the very boxes which were installed with the object of localising such faults. Mr. Bock had all the old boxes removed and the cables jointed through three years ago, and no trouble has been experienced since.

There are at present 100 rectified arc lamps, 45 parallel enclosed, and 15 series enclosed lamps. The tramway routes will all be lighted by direct current series open-type lamps, arranged 6 to 11 in series, and supplied by mains direct from the switchboard, the rails being used for the return. The rectified lamps were supplied by the Brockie-Pell Co., and all enclosed and direct-current lamps by the British Thomson-Houston Co.

ELECTRICAL EQUIPMENT OF TRAMWAYS.

The whole of the electrical equipment of the tramway system, comprising the overhead equipment, the tramcars, the feeder cables and the generating plant, has been carried out to the design and specification of Mr. James K. Bock, all the cable work being carried out by the Electricity Department's staff. In this work Mr. Bock has been ably assisted by Mr. Bullock, chief assistant and mains superintendent, and Mr. Withycombe, superintendent of overhead equipment.

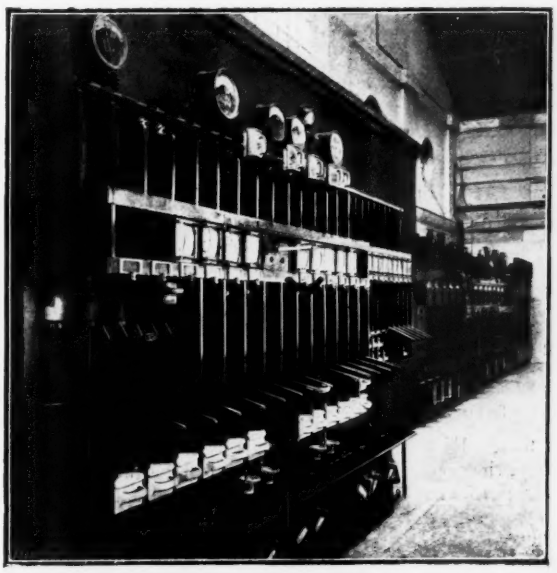
Six main positive feeders supply pillars which are situated on the routes in various central positions, from which sub-feeders are taken to supply the trolley wires through section pillars, situated at distances of not more than ½ mile apart.

The equipment of the main feeder pillars consists of main bus-bar supplied by feeder cable through single-pole quick-break switch, I.T.E. circuit-breaker and single-pole switch on each sub-feeder, Garton lightning arrester, telephone and pilot-wire plug contacts. The section pillars are fitted with bus-bar, switch fuses on cable to each trolley wire, single-pole switches on each incoming feeder, lightning arrester, and telephone and plug contacts.

Two negative pillars are fixed, one at Canning Town Station, at the point of the rails nearest to the works, *i.e.*, 860 yards distant, and the other at Church Street, a central point, 4,280 yards distant. The negative bus-bar at the works is not "earthed," the earth connections being made at the negative pillars. The negative feeders are connected to the rails at Canning Town by 12 No. 0000 S.W.G. copper bonds, and at Church Street by eight No. 0000 S.W.G. copper bonds, and also at both places through recording ammeters to the water mains.

The sizes of the positive feeder cables are, ·75, ·6, ·4, and ·2; the negatives, ·75, and the line sub-feeders ·2 and ·15 sq. in. section.

All the cable is single, lead-covered, paper-insulated, manufactured by the British Insulated & Helsby Cables, Ltd., and has been drawn into 3-in. Albion earthenware conduits with Stanford joints. The mains for lighting and tramways have been laid simultaneously, but the conduits and pulling-in boxes have in each case been kept distinct, as will be seen by the illustration on p. 591.



Main Switchboard: Ferranti Lighting Switchgear.

Main Switchboard: B.T.H. Traction Switchgear.

The contractors for the overhead equipment are Messrs. Macartney, McElroy & Co. of Westminster. Very heavy trolley wire has been used, *i.e.*, No. 0000 S.W.G., and the fittings are proportionately heavy; notwithstanding the difficulties consequent on the erection of this wire, the contractors have made a very neat and satisfactory job of the work.

The trolley wire is anchored on either side of each section insulator and splicing ear, on the "vertical plane system," and Mr. Bock has adopted this system on curves by anchoring the bracket arm to the pull-off pole, and the trolley wire to the bracket.

Side-pole construction has been used throughout, except at curves, crossings, and roads necessitating a bracket arm of over 20 ft. The poles are in three sizes, A, B, and C, A poles being used on the straight, B on curves, and C at pull-offs and anchors; the respective weights being, 1,000, 1,300, and 1,600 lbs. The total length is 31 ft., made up

of three sections shrunk together. They are sunk 6 ft. in the ground and rest on slabs of York stone, the space around the pole being filled in with concrete to a thickness

Laying Cable Ducts for Lighting and Traction.

of 9 in. Each alternate pole is arranged to carry an arc lamp, the bottom scroll in this case being composed of gas tubing to take the wires. The length of the bracket arms varies from 6 ft. to 22 ft. Flexible bow-string suspension with double insulators has been adopted throughout; 24-in. straight and 30 and 33-in. curved ears are used, all of which are soldered. 7/14 S.W.G. stranded galvanised steel guard wires are used, and every alternate pole, every pole carrying feeder wires, and every fourteenth ordinary pole, are bonded to the rails. Section insulators of the "air-gap" type are fitted at intervals of not more than half a mile apart, and the trolley wire is fed at these points.

A complete system of telephones has been installed on the General Electric Co.'s system, each feeder and section pillar being provided with a small door in the upper panel, which, when open exposes a plug contact, to utilise which a portable telephone set is provided on each car. Pilot wires are run to the end of each route from the generating station, which register the drop of pressure between these points and the station.

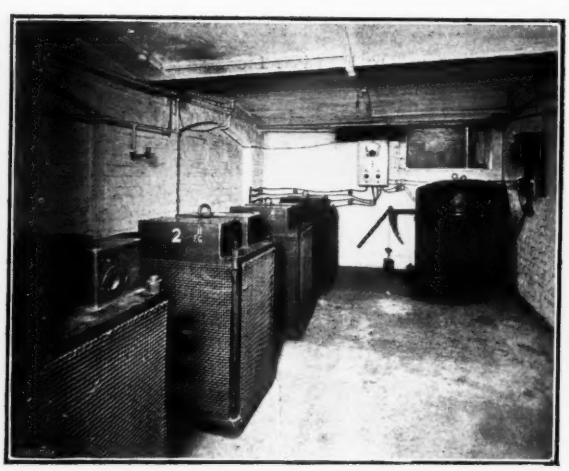
A contract for 50 cars was given to Messrs. Witting, Eborall & Co., Ltd., the sub-contractors being as follows :—Car bodies, Messrs. G. F. Milnes & Co. ; trucks, the Brush Electrical Engineering Co. ; controllers, &c., the British Thomson-Houston Co. The cars have a seating capacity of 56, 34 outside, and 22 inside.

The cars are finished plainly, but at the same time in the best manner, no cushions or curtains being used. The seats are of three-ply birch veneer, perforated, and the roof of bird's-eye maple. The staircases are of Messrs. Milnes' well-known ordinary type with overhead canopy, giving the advantages without the disadvantages of the reversed staircase. The seats on the canopy have been arranged in rather a novel manner around the end of the deck, providing a roomy landing for passengers and also an additional seat. This arrangement was made to the designs of Mr. Bock. Each car is fitted with two 25-h.p. Witting series motors, specified to have a drawbar pull of 1,200 lbs. at the periphery of a 30-in. wheel at a speed of 8 miles per hour for a period of 1 hour, with a maximum temperature rise of 75° C.

Tidswell lifeguards, hand and rheostatic brakes, Blackwell swivelling trolley, and British Thomson-Houston series-parallel controllers are fitted, and also Garton lightning arresters and automatic switches.

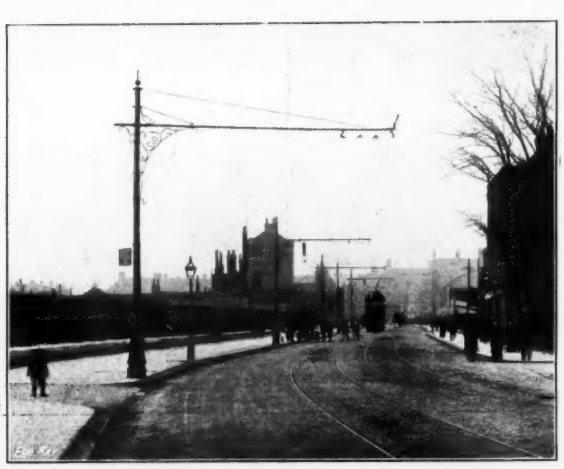
The track has been laid by Mr. Fred Osman, of Southampton, to the specification of Mr. J. Edward Waller, the work being superintended for Mr. Osman by Mr. William H. Davis. Mr. H. E. Blain—formerly of the Liverpool Corporation—is tramways manager, to which position he was appointed in July, 1903.

The chairman of the Lighting and Tramways Committee is Mr. Alderman Ivey, formerly connected with the British Electric Traction Co. The borough electrical engineer, Mr. James K. Bock, has accepted an appointment in Buenos Ayres for Messrs. Livesay, Son & Henderson ; and Mr. W. J. Bullock, at present chief assistant and mains superintendent, who has ably assisted Mr. Bock in this work, has been appointed as his successor.



Transformer Chamber at the Town Hall.

Low-pressure Switchgear and Terminals in Sub-station.



View of Overhead Equipment.

All the photographs here reproduced were supplied by Messrs. W. E. Wright & Sons, of Forest Gate, E., except two by Mr. F. W. Clark, also of Forest Gate.

The Opening Ceremony.

The formal opening of the new station took place on Wednesday afternoon, April 6th. The ceremonials of opening the building, starting the engines, switching on the current to the lighting and tramway mains, and presenting souvenirs to the Mayor and Mayoress, were performed, and the company then proceeded to a marquee to listen to a great deal of talking, which was, for the most part, of the usual West Ham order. The platform furniture was nearly all in position, but Alderman Ivey, who presided, called out to the large assembly, "Has anyone seen Mr. Bock?" and a voice from a fellow member of the Committee replied that he was last seen "in the automatic stoker!" The retiring chief shortly arrived, together with his successor, Mr. Bullock, but to the calls, "Send for Mr. Morley, the borough engineer!" the only answer was an echo. We overheard in the tea-room subsequently that Mr. Morley believed in working rather than talking. Alderman Ivey called upon the Mayor to declare the building open, which his Worship did in a few well-chosen words, in the course of which he paid a tribute to the officials, singling out for especial praise, Mr. Bock, to whose departure from West Ham on Friday (to-day) he could not refer without pangs of regret.

Alderman Ivey followed with a speech which would have entertained our readers. His remarks were largely devoted to the work of the engineers and contractors. The name of Ferranti, Ltd., had been the cause of many warm debates in the West Ham borough, but, after years of experience, they could not complain of the treatment meted out to them by that firm, or of the results attending the working of the engines. He turned to the early history of the Ferranti engine, describing it as a new type of engine—"the high-pressure alternating system." He spoke in the following endearing terms of Mr. Bock:—"Good-bye, Mr. Bock! Good luck, Mr. Bock! *Come back a better man than you are now*, Mr. Bock!!" At which the audience laughed right merrily, much to the Alderman's bewilderment. Of course, Mr. Ivey had to explain it away by saying that the older a man was the better he was (then West Ham ratepayers ought to vote solid for older men at the next election). Things did not always work smoothly, with 48 different Councillors holding 48 different opinions (good luck, Mr. Bock!) In "scrapping" the old station at Abbey Mills and putting down this new works, they were going to effect great economies. An electricity works should be run on business lines or it would fail; there ought to be no loss to the ratepayers; they had invested nearly £700,000 in tramways and electric lighting; it was the advice of an engineer which meant either failure or success—all these and many more remarks came from the lips of of Alderman Ivey.

Of the speech of Alderman Athey, moving thanks to the Mayor and Mayoress, perhaps we had better be silent. When this person had ended his contribution to the programme, the chairman remembered that he had forgotten the speeches of the contractors and the engineer.

Mr. Bock took some pride in the fact that he was "no speaker—only an engineer; his speech was to be found inside the station." In regard to the principal contractors, Messrs. Ferranti, West Ham was one of the first boroughs to adopt their new type of engine. There was a little trouble with the first engines, but he could not praise Messrs. Ferranti highly enough for the magnanimous way in which they had dealt with the Council. Their first contract was for four engines and dynamos costing a considerable sum of money, and those engines were running, and supplying the light for four years, but they did not meet with the makers' approval, and they took them back and gave the Council the full value which had been paid for them. Any remarks made against Ferranti's plant were without foundation. They had put in seven of their new engines, which had been running for the last four months, and the makers had never touched them, yet they were running and doing good work. In regard to the financial side of the business, for the first year or two they could not expect to make a profit, for they had heavy capital charges to meet, and had to find the load for the plant. For at least two years they *must* make a loss, they were bound to do so; but after that they would get even and go on smoothly, and the profits would be proportionately large, judging by the respective sizes of the original and the new installations. He could not forbear a reference to the cold water that had been thrown on the scheme, and also, at one point in his speech, said that things had not always worked quite happily under the West Ham Corporation, but he supposed that remark applied also to every kind of employment.

Mr. Ferranti followed with a few plainly-spoken truths, rubbing it in that West Ham councillors didn't know what they were going in for when they plunged into electric lighting; they were *trading*, and must do the work on a large scale if they were to succeed. They now seemed to have realised the necessities of the case, and had got such an undertaking as was capable of becoming a considerable financial success. Mr. Ferranti referred to his "happy experience" of being connected with the West Ham electricity undertaking since its beginning. The borough engineer was again "shouted" for, but was still a-missing.

CONTRACTS OPEN.

(*Continued from page* 584.)

St. Pancras. — April 12th. Two 1,000-kw. turbo-dynamos, switchboards, &c. See "Official Notices" April 1st.

Spain.—April 12th. Tenders are being invited until the 12th inst. by the Spanish Post and Telegraph Authorities in Madrid for the supply of 50 tons of galvanised iron telegraph wire, 4 mm. diameter. Tenders are to be sent to La Direccion General de Correos y Telegrafos, 10, Carretas, Madrid.

Spain.—April 14th. The Municipal Authorities of Colmenar de Oreja are inviting tenders until the 14th inst. for the concession for the electric lighting of the town during a period of 10 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Colmenar de Oreja (Madrid province).

Tynemouth.—April 22nd. Meters, indicators, and motor hiring for the Corporation. See two "Official Notices" March 25th.

Westminster.—April 18th. High and low-pressure switchboards for the Westminster Electric Supply Corporation. See "Official Notices" March 18th.

Woolwich.—April 14th. Electric crane. See "Official Notices" April 1st.

CLOSED.

Bermondsey.—The B.C. has accepted the following tenders for annual supplies:—

Arc lamp carbons, Birmingham Carbon Works, £3 12s. per 1,000 pairs.
Meter boards, Johnson & Phillips, £15 per 100.
Meters, Chamberlain & Hookham.
Demand indicators and cut-outs, Reason Manufacturing Co.
India-rubber cable and jointing material, British Insulated & Helsby Cables.
Lead-covered cables, Johnson & Phillips.

Gloucester.—The T.C. has accepted the following tenders:—

British Electric Equipment Co., Ltd., arc lamp pillars, £8 19s. 6d. each.
Gilbert Arc Lamp Co., Ltd., 123 arc lamps, £1,395 12s. 6d.
Callender's Cable & Construction Co., Ltd., excavating and refilling new trenches for cables, 2s. 3d. per yard run.
Electrical Power Storage Co., Ltd., maintenance of new battery for 10 years at £90 a year.
Messrs. J. G. Slatter & Co., electrical equipment for the Cross sub-station, £72.

Gravesend.—The T.C. has accepted the tender of Graham, Morton & Co. for the supply of a coal elevator at the E.L. works at £99 10s., and that of Zimmer & Co. for coal conveying plant at £178 10s.

London.—The following tenders have been received by the London County Council for the supply and erection of a 30-ton electric jib crane for use at the wharf in connection with the Greenwich power station:—

Ransomes & Rapier (accepted)	£3,105
Jessop & Appleby Bros.	3,111
J. Booth & Bros.	3,334
Cowans, Sheldon & Co.	3,402
G. Russell & Co.	4,548

The contractors are to be allowed to sublet the motors and controllers to the Electric Construction Co.

Swindon.—The T.C. has accepted the tender of Messrs. Edwards, Bags & Rye, of Swindon, for the supply of electrical fittings for the ensuing year.

Keighley.—The Tramways and Electricity Joint Committee has accepted the following tenders for electric tramways:—

P. & W. MacLellan, Ltd., Glasgow, for rails, £4,971.
Hadfield's Steel Foundry Co., Ltd., near Sheffield, for points and crossings, £1,179.
Blackwell & Co., London, for overhead equipment, £2,960.
British Thomson-Houston Co., Ltd., Rugby, for cars, £4,119.
W. T. Glover & Co., Ltd., Manchester, for cables, £1,690.
Johnson & Phillips, Old Charlton, Kent, for switchboard, £378.
Fred. Waterhouse, Oakworth, for car shed, £680.
Marple & Gillott, Sheffield, for purchase of old rails at 50s. per ton.
Knott & Barker, Ltd., Grimsby, for 700,000 creosoted wood blocks, £3,248.

Pumpherston Oil Works.—Messrs. Bruce Peebles and Co., Ltd., of Edinburgh, have received the contract for the complete installation of three-phase machinery at these works, embodying two 750-kw. alternators coupled direct to Willans engines, and upwards of 60 motors of varying capacity.

Poplar.—The Electricity Committee has received the following tenders for supplying motor-generators, two 250-kw. sets and contingencies:—

The Electrical Co.	£7,392 0
British Thomson-Houston Co.	8,923 0
British Westinghouse Co.	8,345 0
Dick, Kerr & Co.	8,532 0
Mather & Platt, Ltd.	8,740 0
Bruce Peebles & Co., Ltd.	9,050 10
Do. (alternative, Bragstad and La Cour's motor-generators) (recommended)	7,815 10
General Electric Co., Ltd.	9,060 0
Johnson & Phillips	9,205 0
Siemens Bros.	9,661 0
Electric Construction Co.	10,075 0

The Committee rejected the lowest tender, *i.e.*, that of the Electrical Co., as the plant offered would be made in Germany. For switchboards and gear the following tenders were received:—

Johnson & Phillips (no details of construction given)	£2,970 0
Cowans, Ltd., Manchester (recommended)	3,078 10
Kelvin & James White	3,297 12
Ferranti, Ltd.	3,600 0
Siemens Bros. & Co.	3,670 0
Electric Construction Co.	4,537 0
British Thomson-Houston Co.	4,930 0

Stepney.—The B.C. has received the following tenders for the supply and erection of a steam turbo-generator:—

Name.	Maker of dynamos.	Maker of turbine.	Price.
Willans & Robinson	Siemens	Willans	£7,198
Bruce Peebles & Co.	Peebles	Willans	7,198
Do.	Do.	Parsons	7,978
Brush Electrical Co.	Brush	Brush	7,347
C. A. Parsons & Co. (accepted)	Parsons	Parsons	7,724
Do.	Siemens	Do.	7,918

For the supply and erection of four boilers and accessories:—

Babcock & Wilcox, Ltd. (accepted) £9,375.

Stourbridge.—The U.D.C. on 30th ult. accepted the following tenders:—

Engine and dynamos, Belliss engine and Bruce Peebles dynamo	£1,467
Boiler, Babcock & Wilcox	550
Battery, Electrical Power Storage Co.	1,100
Crane, Rodgers & Kaye	85

FORTHCOMING EVENTS.

Friday, April 8th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester). "Direct-Current Controllers," by Mr. H. N. Dutton.

Saturday, April 9th.—At 7.30 p.m. West Hartlepool Scientific Society. Annual meeting.

At 2 p.m. North of England Institute of Mining and Mechanical Engineers. Discussion on "The Electrical Driving of Winding Gears," by Mr. F. Hird, and to be read: "Electrical Winding in Germany," by Mr. W. C. Mountain.

Tuesday, April 12th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester). Annual general meeting.

At 8 p.m. Institution of Electrical Engineers (Glasgow). "Corporation Telephones," by Mr. A. R. Bennett.

Wednesday, April 13th.—At 6.30 p.m. London Electrical Contractors' Association. Dinner at Holborn Restaurant.

At 2.30 p.m. Institution of Civil Engineers (Students). Visit to the Great Northern, Piccadilly and Brompton Railway works.

Thursday, April 14th.—At 5 p.m. Royal Institution. Prof. Dewar on "Dissociation." (Lecture I.)

At 8 p.m. Institution of Electrical Engineers. "Direct-Reading Measuring Instruments for Switchboard Use," by K. Edgcumbe and F. Punga, further discussion; "Eddy Currents and Eddy Current Losses in Cable Sheaths," by Mr. M. B. Field.

NOTES.

London County Council.—At a meeting of the London County Council on March 29th, the Parliamentary Committee presented a report relating to the North and South Woolwich Railway Bill, which the Council opposed before a Committee of the House of Commons, and which was eventually withdrawn by the promoters owing to the insertion of clauses suggested by the County Council.

Mr. R. M. Beachcroft asked what modifications had been suggested by the Committee which had caused London to lose the advantages of the proposed subway railway. In reply, Mr. Shepheard stated that the Committee contemplated the construction of a Council railway under the Thames. The promoters of the Bill asked for a monopoly, but the Council objected, on the ground that it had as much right to go under the river as the company, and that it had already paid £37,000 compensation in connection with the establishment of the Woolwich Ferry, and that the passing of the Bill in the form submitted by the company would have compelled the Council to pay for the company's rights on the elaboration of the County Council scheme.

The Council resolved to seal a petition for presentation, if necessary, in order to secure amendments in the Electric Lighting (London) Bill, 1904, of a similar character to those sought to be obtained in the Bill of the same character when introduced a year ago. The amendments desired are in the direction of affording probation in the matter of price and supply of energy and fittings to existing consumers in areas to be transferred under the Bill. It is also proposed that the Board of Trade, before making or postponing any transfer under the Act, should consider representations made by the County Council and by a Borough Council concerned and by any other body or person appearing to the Board to be interested. The amendments were refused by the Board of Trade in 1903, and will not be entertained in the present Bill. It was also decided to seal petitions to be presented in the House of Lords in order to secure further amendments in the Baker Street and Waterloo Railway Bill and in the Charing Cross and Hampstead Railway Bill.

The Highways Committee reported that the Greenwich Borough Council had not seen its way to agree to contribute one-third of the cost of the street widenings, in so far as the Greenwich district is concerned, contemplated in connection with the reconstruction as a double line, of the existing tramways from London Street, Greenwich, to Rushey Green. On the recommendation of the Committee, the Council resolved not to proceed with the application to Parliament in so far as it affects the Greenwich portion of the tramways in question.

The chief officer of tramways had reported to the Highways Committee on the question of certain requirements which could not easily be foreseen when the reconstruction of the tramways was originally projected. It was necessary to expend £370 on the provision of additional plough hatches, £1,200 for plough-drying apparatus, £300 for pits at termini for adjusting and cleaning ploughs, £400 for new circuit-breakers, £150 for improvements to plough-carriers and conductor tees, and £80 for fixing hand-gear on car-traversers. It was decided to sanction this expenditure, the bulk of which is necessary to provide for the working of the lines during wet weather, when the conditions are exceptional.

The Council decided to sanction an estimate of £7,000, and authorised the Highways Committee to expend that sum in the provision of a temporary power station at Bankside for the working of further portions of the tramways, about 3 miles in length, in the districts of Southwark and Bermondsey. It was also resolved to enter into an agreement with the City of London Electric Lighting Co. for the supply of energy at 2d. per unit, the temporary station to be erected on land belonging to that company at Bankside. The Committee were authorised to obtain tenders from a few selected firms for the supply of the necessary plant and electrical equipment.

Car Works for Sale.—The car building works of G. F. Milnes & Co., Ltd. (in liquidation), at Hadley, are to be offered for sale by auction as a going concern, early in May, by Messrs. Wheatley Kirk, Price & Co. A preliminary announcement is given among our advertisements to-day.

Yorkshire College, Leeds.—In the twenty-ninth annual report of this well-known institution special note is made of the changes in the constitution of the Victoria University, and the probable establishment of a University in Yorkshire, in which the Yorkshire College will be merged. Efforts are being made to increase the capital and income of the college, in readiness for the impending change. The Clothworkers' Co. has offered to transfer to the University, when formed, the buildings and equipment which constitute the Clothworkers' Departments, and which have cost £70,000; the company will also grant a sum of £4,000 per annum to the University. A similar subsidy has been voted by the Leeds City Council, and other contributions have been promised.

Football.—A football match between the Reading Corporation Tramways' employés and the London United men was played on Wednesday last week on the Amateur Sports' Club Ground at Reading. The takings were in aid of the funds of the Reading Corporation Tramways Athletic Club. There was a large attendance of spectators; the Deputy-Mayor and several members of the Corporation were present. The match ended in a win for the Reading Tramways by three goals to two.

Subsequently the two teams, with a number of their supporters, sat down to a substantial tea at the Abbey Café, through the kindness of Mr. Councillor A. H. Bull, who presided, supported by Mr. Walter Binns (general manager of the tramways), Mr. A. G. Shearer (assistant tramways engineer), and others.

McMillan Memorial Fund.—We are informed by the Institution of Electrical Engineers that the committee of the Electrical Engineers' Ball unanimously decided, with the concurrence of those interested, to ask the Committee of Management of the Benevolent Fund of the Institution to receive a cheque for £56 12s. 11d., the balance remaining in their hands after paying all expenses connected with the ball; this amount to be applied by the Benevolent Fund Management to the McMillan Memorial Fund.

Electric Shock Fatalities.—At Stratford on 30th ult. an inquest was held into the death of George Crates, aged 22, a switchboard attendant at the Charing Cross and City Electric Light Co.'s generating station at Pudding Mill Lane, Stratford. Mr. Peter Grain represented the company; and Messrs. Ram and Younger were present on behalf of the Board of Trade. Crates had been employed by the Charing Cross and City Co. for about six months, and was regarded as a capable servant. He had been employed in large stations at Bristol and at Chelmsford. The *Times* report shows that on the 28th ult. he went to work as usual at about 6.30 a.m., and at about 11 o'clock arrangements were made to "shut down" a particular section in order that some repairs might be done. All the sub-stations reported that they had removed their loads, the speed of the engines was brought down, and the voltmeter at the generating station stood at zero. Signals were then given that "all was clear," and Crates proceeded to remove the fuses from the switchboard, which were according to all indications "dead." Crates removed six out of nine fuses safely, and was apparently in the act of removing the seventh fuse when there was a report and a flash and he fell on his back with the fuse in his hand. The fuse was not damaged except that its glass was broken by the fall. Efforts were at once made by Crates's colleagues to restore respiration, but he died before the arrival of the medical man who had been sent for. Dr. S. Alexander said that Crates was scorched on the face and his hair was singed. He had died from an electric shock. Mr. Walter H. Kingston, the engineer in charge of the generating station, in reply to Mr. Ram, said that the current was shut down in order that a cable might be cut off. After this was done he (witness) would have had no hesitation himself in touching the fuses with his bare hands, and Crates with his experience probably had a similar confidence. Special tongs with insulated handles were provided, and there were india-rubber mats. There were regulations as to the tongs, which it was provided should be used to remove the fuses whether they were "alive" or "dead." No one would think of touching the fuses when they were "alive"; the tongs were provided for them when "dead" as an extra precaution, but it was known that when the switchboards were cleaned before the works started each morning the fuses were removed by hand. Everything that could be done to render the fuses "dead" had been done; there was no possibility of connection with the other stations, or between the generator and the cable. The occurrence was inexplicable; it could only be suggested that it arose from a static charge. In that case, had the man used the special tongs he would not have received a shock. Asked to explain how it was that Crates had removed six fuses successfully and received the shock with the seventh fuse, witness said that possibly Crates caught hold of the first six by the glass centre, but with the seventh touched the metal. If there had been a current on, distinct from the static charge, Crates could not have touched even the glass. The jury returned a verdict of "Accidental death," and expressed their opinion that the company should see to it that all their rules for the safety of their workmen should be strictly enforced.

It is to be hoped that this sad occurrence will not be allowed to remain "inexplicable." We are candidly sceptical as to the possibility of death being inflicted by a static charge, and we are astonished that such a suggestion should have been seriously put forward. It would be a reasonable and proper precaution in such a case not only to make the bus-bars "dead," but to connect them with earth before proceeding to handle the apparatus.

On March 27th, Thomas Price, a mechanic at Tirydail Colliery, was called to examine the electric pump; in trying to locate an electric leakage his hands came into contact with a live wire, and he was instantly electrocuted.

Labour Clauses and Foreign Competition.—"A Puzzled Free-Trader" writes to the *Times* as follows, under the heading "Unfair German Competition":—

"It appeared recently from the Glasgow papers that the Glasgow Corporation, in accepting the tender of a German firm for about £10,000 of electrical apparatus, decided that the 'fair wages' clause, required by the standing orders of the Corporation to be inserted in every municipal contract, would be met by the German firm undertaking to pay their workmen in Germany, while employed on this particular contract, the standard rate of wages required by the clause.

"As I understand the matter, these 'fair wages' or 'fair contracts' clauses are now almost invariably inserted in all corporation contracts, their object being to ensure that the contractors pay all their workmen the rates of wages recognised as standard by joint agreement between the trade unions and the employers' associations of this country.

"It would seem, therefore, to be a serious additional obstacle in the way of British manufacturers for an important Corporation like Glasgow to hold that it sufficiently meets the 'fair wages' clause if a German firm, although it is well known that the usual standard German rates of wages are lower than obtain in England, undertake to pay those of their workmen who are engaged on the particular contract and merely for the period while they are so engaged the rates recognised as standard in the district in which the contract is given. Indeed, the result of such a decision seems to be so contrary to what is the undoubted intention of the clause as to make the insertion of it in municipal contracts of no avail for the objects intended.

"I am one who has hitherto been a believer in free trade, but I confess that this, which is to me a novel aspect of the dangers of foreign competition, makes me think seriously of the necessity for some measures of protection. While I am unwilling to suggest any restrictions on individuals or firms having perfect freedom to buy in the cheapest market, there does seem to me good ground for the insertion in municipal contracts which are to be paid for out of public money contributed partially by the rates paid by labouring men, of a clause to ensure the work being done by British workmen.

"It is at least not an unfair thing to ask in the interests of British manufacturers, who have continuously to meet the requirements of the trade unions in the matter of paying standard rates of wages and observing hours of labour, that municipal corporations should not allow the 'fair wages' clause to be evaded in the manner above mentioned."

Obituary.—It is with deep regret that we have to record the death of Mr. J. Staats Forbes, whose main connection with electrical affairs consisted of his chairmanship of the National Telephone Co. and the Edison & Swan United Electric Light Co., both of which offices he vacated only a year or two ago. Mr. Forbes carried his years—he was 81 at the time of his decease—remarkably well, and whenever he met his shareholders was youthful in spirit and in the happiest of moods. His striking figure, ready wit, banter, and good-humoured sarcasm, and his ability for soothing irate shareholders, or talking them down, made him invaluable as a chairman of companies which were sailing through troubled waters, and he was able to command unusually large fees without the least difficulty. The services rendered by him to the National Telephone Co., in the negotiations with the Post Office, are said to have been of the utmost importance to that company. His connection with the Ediswan Co. was less satisfactory, and probably few harder things have been said about him at a city meeting than were expressed by shareholders of that company at a memorable meeting a few years ago, when it was found that things were in a parlous condition and it was announced that Mr. Forbes had left the board. He was often able to turn up a bright side where everyone else failed, and it was his ability in this direction which prevented his ever being at a loss, whether as a railway, telephone or electric light chairman.

Personal.—The Tramways Committee of Burnley T.C. has increased the salary of Mr. Mozley, tramways manager, from £350 to £400 per annum.

On Wednesday Lord Kelvin was elected Chancellor of Glasgow University in place of the late Lord Stair. We tender our sincere congratulations to his lordship upon the conferment of this latest addition to his list of honours.

The South African Association for the Advancement of Science.—The second annual meeting of the South African Association for the Advancement of Science, the counterpart of the British Association in this sub-continent, was opened at Johannesburg on Monday last, when Sir Charles Metcalfe delivered the inaugural address. Lord Milner occupied the chair. The *Times* correspondent says that the proceedings, which include the reading of 56 papers, were to last for one week. Sir Charles Metcalfe's address was regarded as an able *résumé* of the most recent progress made in the scientific knowledge of the world.

Lecture.—A paper on "Electric Light and Fire Risks" was read before the Aberdeen Mechanical Society on the 25th ult., by Mr. J. Erskine Marr, consulting engineer.

Concert.—The last Bohemian Concert of "The Electricals" for the present session is to be held to-night, April 8th, in the Banqueting Hall of the Frascati Restaurant, W. The chair will be taken at 7.45 p.m.

The German Society of Electro-Chemists.—The annual meeting of the Deutsche Bunsen Gesellschaft is to be held this year at Bonn, on the three days May 12th to 14th; and the following provisional list of papers has been published by the Committee charged with the arrangements for this 1904 meeting of the Society:—

Prof. Arrhenius, Stockholm, "The Chemical Mass Action of 'Toxines.'"
Prof. Roozeboom, Amsterdam, "The Application of the Phase Rule to the Mixtures of Iron and Carbon."
Prof. Bredig, Heidelberg, "The Catalysis of Cyanogen Compounds."
Prof. Dreser, Elberfeld, "The Determination of the Freezing Point and Conductivity of Urine."
Prof. Elbs, Giessen, "Electro-Chemical Reductions."
Dr. H. Goldschmidt, Essen, "The Ruthenberg Electrical Concentration and Reduction Process for Iron Ores."
Prof. Heyn, Charlottenburg, "The Hardening of Steel from the Physical Chemist's Standpoint."
Dr. Lob, Bonn, "Pyrogenic Reaction and Dissociation Phenomena."
Prof. Mathesius, Charlottenburg, "The Production, Constitution, and Utilisation of the Slags, produced in Metallurgical Operations."
Dr. Wolf-Müller, Mülhausen, "The Passive State of the Metals."
Prof. Ostwald, Leipzig, subject not yet settled.
Dr. Sackur, Berlin, "The Lead-Tin Alloys."
Dr. Schroeder, Bonn, "The Relation of 'Kryoscopie' to Medical Science."
Prof. Tammann, Göttingen, "Glass Formation and Devitrification."

Further papers are expected, and as Bonn is one of the most charming and attractive of German university towns, a successful gathering, in point of numbers and interest is to be looked for.

Sydney University School of Engineering.—From the *Australian Mining Standard* we learn that Mr. P. N. Russell, who, in 1896, endowed the school of engineering at the Sydney University with the handsome sum of £50,000, has now, through Sir W. P. Manning, intimated his willingness to provide another £50,000, the income of which is to be devoted towards maintaining free scholarships in engineering at the University, and towards extending the teaching of electrical engineering. "The scholarships are to be open to apprentices at the various engineering works in the State of New South Wales and to those who qualify at the technical colleges. The money may be made available at once, the only condition being that the State Government shall undertake to provide within three years £25,000 for the cost of the buildings necessary to accommodate the increasing number of scholars who desire to study engineering."

The Rating of the London United Tramways.—On Wednesday the appeals of the London United Tramways Co. against the assessment of their lines by the Brentford Assessment Committee was concluded. The case was thought to be important as bearing upon the rateability of the electric tram systems of the country, but there was really very little of interest in it, though—it is said the costs will amount to over £10,000. About a dozen applications for adjournment were made by counsel representing the parties before it was commenced, and five whole days had been occupied by Sir Ralph Littler, C.B., K.C., and a large number of Middlesex magistrates in hearing it.

The case for the company was that it must be assessed per car mile run, and that the company was entitled to keep a banking account of £10,000. If the working expenses were put at 4·16 pence per mile, and 1,096,386 miles were run in a year, with various other figures, the cost would be £104,742. The electric cars would cost 1·06 pence per car mile to keep in repair. The company put the assessment at £13,659, the Assessment Committee fixed it at £18,540.

A long list of witnesses deposed to the figures, among them Mr. R. Hammond, M.I.E.E., who said the cables might be expected to last 32 years, the overhead equipment 23, and the cars 14 years. He was of opinion that the figures were favourable to the overseers. The Chiswick generating station was more than was needed for present purposes.

The Committee's witnesses, one of whom, Mr. Cook, said he took the expenses at ·897 per car mile from the company's accounts. He only allowed half the directors' fees, as their services were not confined to this line. The real point of difference was that the company deducted statutable expenses, £43,904, and he £34,025.

Major Cardew said he thought the life of the high pressure 20 years, and the low pressure ones at 30, and their value at the end of that time about £4,000. The company put the cost of the overhead equipment at about double what it should be. He thought £12,000 a mile enough for it.

The Court fixed the net assessment at £11,225, thus finding for the company with costs.

Cost of Generating Electrical Energy.—A paper on this subject, which was read by Mr. E. J. Fox, before the Cleveland Institution of Engineers in February last, contained some interesting data relating to the detailed costs of generation in public and private works. The following tables show in brief the results obtained respectively by the seven towns with the lowest working costs during 1902, and a number of large private undertakings:—

Public Generating Stations.

Town.	Units sold per annum.	Units sold per an. per kw. installed.	Load factor.	Costs per unit in pence. Coal.	Oil, waste, water & stores.	Wages.	Repairs.	Works costs.
				d.	d.	d.	d.	d.
Bradford ..	9,124,223	1,480	20·93%	·26	·05	·08	·13	·52
Leeds ..	4,448,650	508	12·31%	·28	·03	·17	·14	·62
St. Helens	1,237,965	920	17·81%	·26	·03	·17	·19	·65
Edinburgh	7,760,307	742	14·75%	·34	·04	·09	·18	·65
Bolton ..	3,802,598	1,028	18·87%	·35	·06	·15	·10	·66
Bootle ..	1,619,129	1,906	28·44%	·41	·03	·15	·11	·70
Liverpool	23,186,083	1,091	25·11%	·37	·06	·15	·13	·71

Private Generating Stations.

—	Units per year per kw. installed.	Units per week.	Lbs. coal per unit.	Costs per unit in pence. Coal.	Oil, waste, stores, &c.	Wages.	Repairs.	Works costs.
				d.	d.	d.	d.	d.
Watson, Linwood ..	5,400	64,000	3·25	·138	·011	·011	·018	·185
Do. ..	5,400	57,000	3	·153	·012	·021	·021	·207
Do. ..	5,400	44,190	4	·171	·016	·027	·027	·242
Do. ..	5,400	50,880	3·1	·131	·014	·023	·023	·191
Dorman, Long & Co., 1903	5,037	151,122	2·8	·15	—	—	—	—
Do. 1902	5,050	60,400	3·04	·179	·019	·085	·03	·318
Kynoch, day load ..	1,240	18,400	5·5	·190	·046	·065	·043	·348
Do. day and night	1,490	22,400	7·0	·243	·050	·075	·045	·418
City & S.L. Railway ..	2,817	132,195	4·16	·307 water ·01	·037	·064	·038	·446

Plant for Sale.—The Greenock Corporation is inviting offers for a Belliss-Silvertown engine and dynamo, of which particulars are given in our advertisements.

Appointments Vacant.—Electrical engineer for Bray U.D.C. (£240); chief assistant engineer for Preston tramways (£200).

The Paris Metropolitan Railway.—It is expected that the Courcelles—Ménilmontant extension, which will connect Monceau with Ménilmontant, *viâ* the Saint Lazare railway station, the Opéra, the Bourse, the Place de la République and Père Lachaise, will be opened to traffic in July. This will increase the length of the railway from 16 miles to nearly 20 miles. The ratio of working expenses to gross receipts amounted to 41·23 per cent. in 1900, 47·16 per cent. in 1901, 41·48 per cent. in 1902, and 42·64 per cent. in 1903, while for January and February of the present year the figure has been reduced to 39·70 per cent. The capital of the company was increased to £3,000,000 last year, and it will henceforth be able to issue bonds so as to provide funds for proceeding with the lines projected so as to form the second network.

THE CENTRAL STATION ENGINEER.

The Barking U.D.C. has granted honorariums of £25 each to Mr. A. H. Seabrook, engineer, and Mr. R. J. J. Swan, assistant engineer, in respect of extra services rendered in connection with the electric tramways.

Ilford U.D.C. has granted the following increases of salary:—Mr. A. H. Shaw, electrical engineer, from £400 to £450 per annum; Mr. G. R. Spurr, tramway manager, from £250 to £300 per annum, rising by £50 a year to £400.

Bedford T.C. has increased the salary of Mr. Phillips, electrical engineer, by £50 a year, and that of the deputy electrical engineer by £26 per annum.

Wimbledon U.D.C. has increased the salary of Mr. H. Tomlinson Lee, electrical engineer, from £300 to £400 per annum.

The Greenock electricity works staff held their first annual supper and dance on March 25th, Mr. J. A. Robertson, the chief electrical engineer, presiding. Between 70 and 80 ladies and gentleman were present. The toast "The Electricity Committee" was proposed by Mr. Colin MacCulloch, and Treasurer N. M. Brown responded. He showed the progress that had been made since the works were opened, the annual income now reaching £13,000 and the output 1½ million units. Mr. Ward gave the toast "The Works Staff," and the chairman responded. In the course of his remarks he said that Greenock was second to none in regard to reliability of supply, and it was only second to two others in Scotland in the matter of economical working. After further toasts the company adjourned to the saloon to dance.

The Corporation of Bridlington has appointed Mr. A. J. Beckett, of the York Electricity Works, to act as clerk of works for the electric lighting scheme.

Mr. E. S. Lance has been presented with a smoker's cabinet by the engineers in the generating department upon the occasion of his leaving the Brompton and Kensington Electric Light Co. in order to join his brother, Mr. Willoughby Lance, in an engineering contractors' business in Llandudno, N. Wales. The presentation was made by Mr. Langley, the resident engineer. Mr. Lance held the position of senior engineer-in-charge, having been with the company some 2½ years.

The salary of Mr. R. Priestley, assistant electrical engineer at Halifax, has been advanced from £200 to £210 as from April 1st, and to £220 as from April 1st, 1905. Also the salary of Mr. P. Fowler has been advanced from 50s. to 55s. per week.

In reply to advertisements for the appointment of assistant engineer, 71 applications were received by the Leek U.D.C. Messrs. F. Williams, of Maidstone, G. E. Platt, of Warrington, and A. J. Leigh, of Rochdale, were selected to meet the committee.

NEW COMPANIES REGISTERED.

British Textile Design and Electric Card Cutting Co., Ltd. (80,496).—This company was registered on March 29th, with a capital of £10,000 in £1 shares (7,000 7 per cent. preference), to acquire the rights for the Patent Automatic Electric Jacquard Card Cutting Machine, jointly owned by O. Zerkowitz and Zerkowitz Inventions, Ltd., to adopt an agreement with the said O. Zerkowitz, and to carry on the business of designers and card cutters, manufacturers of or dealers in the said card cutting machine, &c. The first subscribers (each with one preference share) are:—G. Clay, 165, Parkside Road, Bradford, machine maker; E. Wood, Thorncroft House, Wibsey, Bradford, cloth merchant; H. Walbank, 23, Cheapside Chambers, Bradford, textile designer; P. Parkin, 1, Town Hall Square, Bradford, textile designer; G. E. Gott, Osborne Chambers, Bradford, incorporated accountant; J. Atkinson, Ryan Street, Bradford, machine maker; and H. Cottam, Cecil Avenue, Bradford, builder. Minimum cash subscription, 2,250 shares. The number of directors is not to be less than three nor more than seven. The first are G. Clay, E. Wood, H. Walbank, and P. Parkin; qualification, 100 shares; remuneration as fixed by the company. Registered office, 23, Cheapside Chambers, Bradford.

Britannia Electric Carriage Syndicate, Ltd. (80,495).—This company was registered on March 29th, with a capital of £12,000 in £1 shares, to adopt an agreement between L. Garcin and A. Renault of the one part, and F. G. Holland of the other part, for the acquisition of patent No. 23,428 of 1902, to manufacture and deal in carriages, carriage appliances and devices, and to carry on the business of electricians, mechanical engineers, machinists, carriers of passengers and goods, omnibus, carriage, and launch proprietors, &c. The first subscribers (each with one share) are:—W. L. C. Dowling, 27, Lillie Road, Earl's Court, S.W., publisher; H. C. Fowler, 80, Grosvenor Terrace, Camberwell, S.E., clerk; E. H. Walker, 65A, Cannon Street, E.C., accountant; J. Pussfarcken, 37, Walbrook, E.C., merchant; H. C. Murray, 65A, Cannon Street, E.C., secretary; F. E. Parish, 29, Clarence Road, Kentish Town, N.W., clerk; and H. T. Rutter, 4, Warrington Crescent, Paddington, W., A.M.I.C.E. No initial public issue. The number of directors is not to be less than two nor more than seven. L. Garcin and A. Renault may nominate one, others to be appointed by the subscribers; qualification, £25; remuneration, £50 each per annum.

Pneumatophone, Ltd. (80,505).—This company was registered on March 29th, with a capital of £3,000 in £1 shares, to acquire the patent rights relating to an invention by H. L. Short for improvements in methods of and apparatus for increasing the volume of sounds from telephonic and phonographic instruments and transmitting such sounds to distances, and to develop and turn to account the same. The first subscribers (each with one share) are:—M. Luite, 175, Wool Exchange, E.C., merchant; F. Newman, Constitutional Club, W.C., secretary; E. A. Boddington, 87, Victoria Street, S.W., gentleman; D. Spurling, Palmerston House, E.C., gentleman; Miss L. M. Daniell, 10, Upper Tollington Park, Stroud Green, N.; C. L. Demson, 55, Bedford Road, Clapham, S.W., clerk; and W. L. Bingley, 121, North Hill, Highgate, engineer. Minimum cash subscription, £7. The first directors are M. Luite, F. Newman, D. Spurling, E. A. Boddington, C. L. Demson, Miss L. M. Daniell, and W. L. Bingley. No qualification for directors prior to 1906, afterwards £250. Remuneration, £50 each per annum and a share in the profits. Registered office, Palmerston House, Old Broad Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Kensington and Knightsbridge Electric Lighting Co., Ltd. (26,193).—This company's annual return was filed on March 9th, when 21,000 ordinary, 10,000 first preference and 10,000 second preference shares had been taken up out of a nominal capital of £350,000 in 50,000 ordinary, 10,000 first preference and 10,000 second preference shares of £5 each. £5 per share has been called up on 15,968 ordinary, 10,000 first preference and 10,000 second preference shares, resulting in the receipt of £179,840. £25,160 is considered as paid on 5,032 ordinary shares. Mortgages and charges: £90,000. Debenture stock issued by this company in conjunction with the Notting Hill Electric Lighting Co., Ltd. £135,000.

Hart Accumulator Co., Ltd. (60,059).—This company's annual return was filed on March 21st, when the entire capital of £40,000 in £1 shares had been taken up. £1 per share has been called up and paid on 17,500, and 22,500 shares are considered as fully paid. Mortgages and charges: Nil. (The capital was increased to £60,000 by the creation of 20,000 new preference shares immediately after the above return was filed.)

North Wales and District Light Railway and Electric Power Syndicate, Ltd. (65,824).—This company's annual return was filed on February 11th, when 11 shares had been taken up out of a nominal capital of £1,200 in 12 shares of £100 each. £924 has been received, leaving £176 in arrears. Mortgages and charges: Nil.

London Electric Wire Co., Ltd. (36,544).—This company's annual return was filed on February 22nd, when 15,807 ordinary and 5,956 preference shares had been taken up out of a nominal capital of £150,000 in 20,000 ordinary and 10,000 preference shares of £5 each. £5 per share has been called up on 8,087 ordinary and 5,956 preference shares, resulting in the receipt of £70,215. £38,600 is considered as paid on 7,720 ordinary shares. Mortgages and charges: Nil.

Chiswick Electricity Supply Corporation, Ltd. (38,854).—Issue, on March 16th, of £1,000 4½ per cent. debentures, part of series created by resolutions of November 2nd, 1900, and March 8th, 1901, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holders: Davey, Paxman & Co., Ltd., Colchester. No trustees. Previously issued of same series: £32,000.

F. A. Glover & Co., Ltd., electrical and general engineers, London (73,856).—Issue, on March 21st, of a £500 debenture, part of series created April 11th, 1902, to secure £6,000 and 6 per cent. interest, charged on the company's undertaking and property, present and future, including uncalled capital (if any). No trustees. Holder: R. F. Wahl, 1, Pembridge Square, W. Total amount previously issued of same series: £5,500.

Finchley Electric Light Co., Ltd. (67,030).—Issue, on March 8th, of £400 debentures, part of series created December 7th, 1903, to secure £2,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £100.

ELECTRICITY SUPPLY ACCOUNTS.

East Ham Municipal Electrical Supply.

The first complete 12 months' working of the East Ham Electricity Department has proved in every way as successful as the previous nine months. Aided by an excellent load factor, resulting on the combination of tramways, street lighting and private supply, in which the two former largely predominate, the costs per unit are well below the average for such undertakings in the vicinity of London. Financially, a satisfactory surplus was earned which, after meeting the interest and sinking fund charges, left a balance of £1,975, which was carried towards an initial expenses account.

The prices charged were:—Private lighting, 7d. and 2d. per unit maximum demand, or a flat rate of 5½d. per unit; power, 2½d.; and traction 2d. per unit; public arcs, £18, and incandescent lamps (20-c.p.), £4 6s. 3d. per annum. The borough electrical engineer and manager is Mr. W. C. Ullmann.

GENERAL STATEMENT.

For year ending March 31st—	1903.	12 months, 1902.
Total capital expended	£87,476	£66,977
Number of units sold—		
Private supply	286,238	120,833
Public lighting	322,303	196,453
Traction	656,125	358,352
Total number of units sold ...	1,411,924	730,642
Equivalent No. of 8-c.p. lamps connected	22,957	13,380
Number of public lamps	169 arc 137 inc.	138
Maximum load in kw.	690	436
Revenue account—		
Gross revenue	£13,540	£7,094
„ expenditure	£7,981	£4,363
„ profit	£5,559	£2,731
Average inclusive price obtained per unit—		
Private lighting	4·12d.	4·13d.
Public lighting	2·12d.	1·97d.
Traction	2·00d.	2·25d.

REVENUE ACCOUNT FOR YEAR ENDING MARCH 31ST, 1903.

Gross revenue	£13,540	= 2·30d. per unit.
Works and distribution costs (inc. pub. ltg.)	£7,004	= 1·18d. „
Total working costs	£7,981	= 1·35d. „

PROFIT STATEMENT.

Interest on loans, &c.	£2,686
Sinking fund	898
Balance on year's working	1,975
Gross profit	£5,559

Hastings Municipal Electrical Supply.

We give herewith the returns of the Hastings Electrical Department for the year ending December 31st last. The undertaking has increased its output, although not in the same ratio as in previous years. Working expenses are, unfortunately, "up" about $\frac{1}{10}$d. per unit, and the gross profit, which is some £200 more than in the previous year, has no doubt suffered from this cause. The deficiency on the year's working amounts to £951, as compared with £1,080 in the previous year.

The progress of the undertaking in recent years will be gathered from the following figures:—

Year.	Equivalent No. of lamps.	Units sold.	Total costs per unit.
1901	29,428	703,814	3·19d.
1902	33,443	803,761	2·75d.
1903	—	852,094	2·85d.

The prices charged are:—For private lighting, 6d. per unit, or 10s. per annum per 8-c.p. lamp, and 1½d. per unit, on the maximum demand system. Mr. R. F. Ferguson is the borough electrical engineer.

GENERAL STATEMENT.

For year ending December 31st—	1903.	1902.
Total capital expended	£131,147	£128,944
Number of units sold—		
Private supply	623,662	575,568
Public lighting	228,432	228,193
Total number of units sold ...	852,094	803,761
Equivalent No. of 8-c.p. lamps connected	—	33,443
Number of public lamps	104	104
Maximum load in kw.	610	601
Revenue account—		
Gross revenue	£17,977	£16,894
„ expenditure	£10,104	£9,220
„ profit	£7,873	£7,674
Average (inclusive) price obtained per unit—		
Private lighting	5·25d.	5·22d
Public lighting	4·22d.	4·34d

REVENUE ACCOUNT FOR YEAR ENDING DEC. 31ST, 1903.

Gross revenue	£17,977	= 5·05d. per unit.
Works and distribution costs (inc. pub. ltg.)	£8,175	= 2·30d. „
Total working costs	£10,104	= 2·85d. „

PROFIT STATEMENT.

Interest on loans	£4,495
Sinking fund	4,311
Sundry	17
Debit balance from 1902 (less £1,000 contributed by rates)	3,518
Debit balance carried forward	—4,468
Gross profit	£7,873

CITY NOTES.

W. T. Glover and Co., Ltd.

The accounts of Messrs. W. T. Glover & Co. for the year ending December 31st, 1903, show a manufacturing profit of £32,025 9s. 3d., dividends and miscellaneous receipts £1,739 13s. 6d., making a total of £33,765 2s. 9d. Management and administration expenses (£20,954 17s. 11d.), interest, bankers' charges, &c., interest on debenture stock, interest on loans, and a sum voted for directors' remuneration, amount together to £30,736 8s. 6d., thus leaving a balance of £3,028 14s. 3d. of incomings over outgoings. The amount brought forward from last year is £4,280 10s. 6d., making a balance to the credit of profit and loss account at December 31st of £7,309 4s. 9d.

The balance-sheet does not separate patents and goodwill from lands, buildings, and plant; all these together being valued at £211,320 6s. 2d., after deducting £6,162 7s., or slightly less than 3 per cent. for depreciation. £132,009 19s. 10d. is owing to the company. The investments and advance payments stand at £51,177 4s. 2d.; stock at £89,892 1s. 6d.; and cash in hand, £722 13s. 10d. The liabilities are £314,850 on shares and debentures, £91,679 19s. 6d. on loans, £54,932 0s. 5d. due to sundry creditors, bills payable, and sundry charges. The debenture redemption and reserve funds amount to £16,351 0s. 10d.

In their report the directors state that "the surrender of ordinary shares of the company to the nominal value of £35,150 by the original vendors has been duly completed, and the reduction of capital by this amount has been approved by the court." They refer to the trade depression, but state that "there are indications of the prospects of the company showing an improvement during the remainder of the current year," and they regret that the result of the working during the past year does not permit the payment of a dividend to the preference shareholders, although the general position of the company is now more satisfactory.

Marconi's Wireless Telegraph Co.

Col. Sir Euan-Smith, K.C.B., presided at the meeting held on March 30th, at Cannon Street Hotel. There was a sprinkling of shareholders and an enthusiastic company of Press representatives. The chairman first referred to the absence of Mr. Marconi in Italy through the death of his father. For a second time since the company came into existence its receipts were in excess of its expenditure, the excess this year being £10,607, as against £5,489 last year. The shares in associated companies, which had a par value of £1,576,500, were taken at cost (£5,239), and the real value must be represented by a sum very largely in excess of that stated in the balance-sheet. The progress of the year had been persistent and sustained. The revenue-producing branches established at the close of the preceding year had been satisfactorily developed, producing increased income. Mr. Marconi had been carrying on a series of experiments in improving the long-distance communication. If some disappointment had been felt that the trans-Atlantic service had not yet been established on a commercial scale—that the hope held out in the speech which was made last year that the difficulties in connection with the trans-Atlantic communication had been overcome had not been fulfilled—"it must be remembered that all scientific progress, before it rests upon a foundation of certainty and security, must be attended by many unforeseen incidents and difficulties." Such difficulties had been twofold—"certain technical difficulties which are now thought to be completely overcome; and difficulties in obtaining inland telegraph facilities." The necessity of surmounting these difficulties had compelled the board up to the present to postpone completion of the arrangements for trans-Atlantic communication, which must necessarily be of a costly character. After referring to the arrangements made in Canada, Italy, and other places mentioned in the report (see Elec. Rev., March 25th) he said that the 12 months reviewed in the report had been mostly spent in concluding contracts which they confidently anticipated would result in considerable profits to the company. In regard to the Admiralty, arrangements had been finally and satisfactorily concluded, and the company's relations with that great department were now of a most cordial and encouraging character. Considerable orders had been placed with the company by the Admiralty for the most up-to-date apparatus. As regards the General Post Office, however, the negotiations, involving several Government departments, had been of a most protracted and complicated character. That was inevitable. Little by little difficulties had been cleared away, obstacles had been removed, conflicting interests had been reconciled, and he was in a position to inform them—with the greatest satisfaction—that late on the previous afternoon the Post Office intimated their readiness to conclude an agreement of which the details had previously been the subject of discussion of a most exhaustive character. The directors thought that that agreement would not only give great satisfaction to the public generally, but would also safeguard the interests of the shareholders of this company. The far-reaching importance of the subject demanded that no final conclusion should be arrived at unless every point had received the careful examination that it deserved. The issues of the agreement must necessarily be of a widespread and national importance. The details of the agreement could not be made public then. They had to pass into the hands of the legal advisers of the Post Office and of the company, and to be duly embodied in contract form. The progress that the Marconi Co. had hitherto made had undoubtedly been due to the intrinsic merits of the system itself. While other countries had supported it, and Germany had fostered the Slaby-Arco system, it was the British practice to give no Government support until an invention had justified its existence. It might be conceded that if at the present moment the Marconi system had been already adopted by the Admiralty, and had now received the promise of the invaluable countenance of the Post Office, it was because the responsible advisers of His Majesty's Government had satisfied themselves not only of the inherent merits of the system itself, but also that it was pre-eminently the best system of wireless telegraphy in existence at the present time, and, "as your board believes, the only practicable system." After dwelling upon the valuable service rendered to the company by Mr. Cuthbert Hall, its managing director, the chairman added that in view of the new responsibility with regard to the construction of new works and development of the system that would devolve upon the board in consequence of the conclusions arrived at with the Post Office, the directors would probably shortly make a new issue of shares. The details regarding the issue and price would be communicated in due course.

The adoption of the report was seconded by Mr. H. Jameson Davis and carried unanimously. The formal vote of thanks to Mr. Cuthbert Hall was also approved. Retiring directors and auditors were re-elected.

Mersey Railway Co.

Mr. James Falconer presided at the meeting held at Worcester House, Walbrook, E.C., on March 30th. He said that the report was undoubtedly of special interest, because it contained the results of the first half-year of electrical working. But the board did not regard the results as giving a complete indication of what the results under electric traction would be. In regard to receipts, they had earned £37,357, as against £29,470 during the corresponding period of 1902. That £8,000 increase was not all they had expected, but it was substantial, and it was during the latter months that the increase had really begun to tell appreciably. There was every indication that as the public obtained experience of, and confidence in, the system of working, the traffic would develop. The number of passengers had increased from 2,844,000 to 4,153,000, which was a larger percentage of increase than the increase in money, so that they were getting less per passenger. They were going to reduce the difference between third and first-class fares. The increase was mainly in the local traffic which arose and terminated on their own line. They had taken up the matter of reducing fares for through traffic with the other companies with which they exchanged traffic. They were also giving season-ticket holders greater facilities. The working expenses were not at all satisfactory to the board. They compared with the 1902 period when steam working was in vogue. The train mileage was 400,000 electrically, against 155,000 by steam in 1902. In 1902 the cost of maintenance of permanent way was 3·9d. per train mile by steam, against 1·6d. by electricity in 1903. The locomotive and generating power, under steam, cost 11·3d. per train mile; with electric traction this item cost 5·2d. per train mile. When they resolved to enter upon electrification the expected figure was 6¾d., so that the actual result was more than a 1d. lower. Car repairs were practically the same, ·9d. against ·8d. He thought that that item ought to be very substantially reduced. Traffic expenses with steam cost 13 5d. per train mile, whereas with electrical traction they were 7·3d.; this item was affected almost entirely by the increase in the train service. The general charges were 3·4d. in 1902, and now 1·6d. per train mile. In ventilation there had been a very satisfactory change. In the old days it cost 3·4d. per train mile, but during the last half year it had been ·2d. The ventilation was perfectly satisfactory, and they had none of the troubles which seemed to vex and harass the tube lines. In regard to pumping, they had through more efficient steam raising plant reduced the cost from £3,084 to £2,619, and from 4·8d. to 1·5d. per train mile. The total result was that under steam working, the expenses were 41·2d. per train mile, and under electrical, 18·2d. Therefore, assuming that they had a situation deserving of service such as they were giving, they could undoubtedly do it with electricity at about one half the cost by steam. In regard to the claims of the company against the contractors in respect of exceptional expenditure for which the contractors were responsible, these questions were before an arbitration tribunal. Therefore he ought not to make a public statement. Other questions were partly regarding finance and partly regarding the works. The board were acting under the best legal and engineering advice available, and with regard to the plant it would not be any fault of the board if, as a result of the proceedings, this company did not find itself in possession of as good an electric plant as modern science could produce; that was the object they sought to attain, and they would certainly persist in it to the utmost of their power. They had not had an accident claim against them during the period.

Mr. Sheppard seconded the adoption of the report, and it was adopted.

Liverpool District Lighting Co.

The annual meeting of the Liverpool and District Lighting Co. was held at Liverpool last week. Mr. Holbrook Gaskell, in moving the adoption of the report, said that after very careful consideration the directors had reduced their charge for the electric light in Waterloo from 6d. to 5d., compared with 3½d. in Liverpool. Their business had been rapidly growing, but had reached a point at which the high price for current would retard progress. The reduction in price had already had the effect of increasing their customers and their business. The increase in consumption of the first two months of this year compared with the same period of last year, was at the rate of 36 per cent., and if this continued the dividend would soon again be 5 per cent. Personally, he thought 5d. per unit still too high, and while they could not be expected to compete with the Liverpool Corporation, they might have to reduce their charge even below 5d., to say 4½d.

The report was adopted.

Willans & Robinson, Ltd.

The directors' report for the half-year ended December 31st, 1903, which is to come before the meeting at Cannon Street Hotel, E.C., on April 13th, reads:—

"The directors have to state with deep regret that the operations of the company in the past half-year have resulted in a loss, and that no dividend can be paid upon either the preference or the ordinary shares. Owing, on the one hand, to depression in trade, and on the other to increased competition, there has been a falling off in orders for engines, as well as in the prices obtainable, the result being that the profit for the half-year upon the engine-building and other business carried on at Rugby (after making a special reserve against depreciation on certain shares receivable in part payment for engines) is only £11,772 5s. 10d., increased to £14,103 13s. 8d., by an amount of £2,336 7s. 10d. brought forward from last half-year. Against this has unfortunately to be set a loss of £22,040 18s. 5d. at Queen's Ferry, in which is included £7,249 3s. 5d. for depreciation. The net debit balance on the profit and loss account is therefore £7,932 4s. 9d. The company is in need of the balance of the new capital (£83,340), which the directors were authorized to issue by the resolution passed on the April 3rd, 1901, and as, under present conditions, a new issue of capital is not likely to be successful, it is necessary to borrow upon the security of the reserve fund investments. It was the directors' intention to issue the new capital a year ago, but they were advised to postpone the issue for a year, and in consequence they made temporary arrangements for an overdraft upon the company's bankers, until the capital should be issued. As this arrangement expires in July next, it is important that a new understanding be arrived at with the bank, and a resolution will be submitted to the shareholders authorizing the directors to borrow up to the maximum amount permitted by the articles of association, viz.:—50 per cent.

of the paid up capital, less the sum already authorized to be borrowed upon debenture stock. The amount of the balance which can be borrowed under this resolution is £83,330. The steel works at Queen's Ferry, including the steel foundry, will be closed as soon as existing orders can be completed; work in the boiler shop and tube works will be pushed on with energy. Extensive reductions are in course of being carried out in the Queen's Ferry Staff and organisation and every effort will be made to effect similar economies at Rugby."

Calcutta Tramways Co.

The report for the year 1903 shows gross traffic receipts £113,756, working expenditure under all heads £55,670, and a revenue balance after crediting sundry receipts of £58,812. After providing for interest on debentures, less the amount earned by the employment of monies in hand, interim dividend, and the special grant to the chairman voted at last meeting, the net amount to be dealt with, including £1,181 brought in from the last account, is £32,666. The directors recommend a dividend at the rate of 7 per cent. per annum for the half-year, making, with the interim dividend, 6 per cent. for the year, tax free, leaving a balance of £14,769, of which the directors propose to credit £12,418 to a depreciation fund, leaving £2,351 to be carried forward. The directors recommend that the amount at present standing to reserve fund, viz., £14,582, should be added to the above amount of £12,418, making a sum of £27,000 to the credit of depreciation fund.

Buenos Ayres and Belgrano Electric Tramways Co.

The report for 1903 states that the total receipts have amounted to £164,714, and expenditure to £92,369, leaving £72,345. This balance, with the amount brought forward from last year, £3,270, has been carried to net revenue account. There has been placed to renewals fund (raising same to £16,000) £5,000, and written off capital expenditure £4,500. To meet a loss on sales of surplus stores there has been written off £1,301. There has been applied to create a sinking fund for the redemption of debenture capital £2,500, and to create an accidents insurance fund £500. The 6 per cent. dividend on the "A" and "B" preference shares absorbs £20,250, and the directors now recommend a dividend of 3 per cent., or 3s. each, on the ordinary shares, leaving £2,479 to be carried forward. 3,210,194 miles were run, an increase of 88,635 miles. The number of passengers increased by 949,781.

Folkestone Electricity Supply Co.

The directors' report for 1903, which was presented at the meeting held at Folkestone on March 30th, showed that the company continues to make satisfactory progress.

Up to December 31st, 1902, the equivalent of 40,699 8-c.p. lamps was being supplied, whilst up to December 31st, 1903, the equivalent of 54,805 8-c.p. lamps was being supplied. There is a profit on the revenue accounts of £6,026 13s., which with the profits on installation work, &c., and the sum of £202 17s. brought forward from last year's accounts, and after allowing for interest on debenture stock, bank charges, &c., and carrying the sum of £1,000 to a depreciation fund, shows a net balance for distribution, after allowing for the interim dividend at the rate of 4 per cent. per annum already paid, of £2,452. Out of this the directors recommend the payment of a dividend at the rate of 7 per cent. for the half-year (making 5½ per cent. for the year), which will require £1,750, and the placing of £400 to the reserve fund, thus leaving a balance of £302, which it is proposed to carry forward to next year's accounts. The agreements with the Corporation of Hythe and the Urban District Council of Sandgate, for working their provisional orders have been carried into effect, and it is hoped that these two towns will prove a good source of revenue.

The capital expenditure for Hythe and Sandgate is included for the first time in the company's accounts, and the items appear in the balance-sheet under separate headings. A suspense account is also included in connection with the Hythe temporary lighting, which it is proposed to write off in the course of two or three years. As the Board of Trade auditor is not authorised to audit the company's expenditure or revenue under the Hythe and Sandgate orders, his audit being strictly confined to the undertaking transferred to the company by the Corporation of Folkestone, his certificate of audit is not attached to the accounts. The audit by the Board of Trade auditor of the accounts connected with the Folkestone undertaking is in progress, but the accounts of the whole of the undertakings worked by the company have been duly audited by Mr. Richard White, the company's auditor.

A further issue of £25,000 preference shares has been made since the close of the financial year to cover extensions in Folkestone, Hythe, and Sandgate, and pay off the bank overdraft. These shares were only offered to the shareholders and debenture holders of the company, and were well subscribed. There is £3,865 still unallotted which can be taken up by shareholders or debenture holders in terms of the circular letter issued last month.

Woking Electric Supply Co.

Mr. John Ashby presided at the annual meeting held on March 29th. He said that the year had been more satisfactory than the directors anticipated it would be. Since 1900 the revenue had risen from £4,000 to £7,951, and their customers from 294 to 660. The proportion of expenses had been reduced. In 1901 the revenue was £4,466, and the expenses £3,617, while the expenses connected with the revenue of £7,951 in 1903 was only £4,043. This result had been brought about mainly by getting rid of antiquated and useless machinery and replacing it by modern dynamos, engines and boilers. They had taken up cable that was worn out and wasteful, and had relayed cables of the best class manufacture. Another reason for the reduction of expenses was the keen supervision maintained over all by their manager, and they had also succeeded in reducing the price of coal per unit generated. The reduction in the price of current to 6d. per unit had had gratifying results, and they had now connected up the L. and S.W. Railway Co.'s station. The minimum supply under the contract was 70,000 units a year, but the maximum amount of current which they would take would greatly exceed their anticipations. In the future he believed the railway company would take current for power purposes as well. The business was healthy and sound, and the directors had no hesitation in applying for extra capital, so long as they could employ it to produce a satisfactory dividend. They had not yet actually decided to do so, but they contemplated applying in the next session of Parliament for additional powers to supply light to some of the neighbouring localities. He had no doubt that all the local authorities concerned would readily acquiesce in the application. But quite independent of this they would require additional capital both this year and next, because they proposed to put up one, or probably two, new boilers, larger than they at present had. They were also thinking of putting up a new chimney shaft 160 ft. high, and they had also given an order for another 400-kw. engine and dynamo.

The report was adopted.

The company's first dividend on the ordinary shares was then declared at 4 per cent. and a dividend. Thanks were accorded to the engineer and manager (Mr. J. G. McLean) and staff.

An extraordinary general meeting of the company was then held to authorise some minor alterations to the articles of association in order to secure a quotation on the Stock Exchange.

W. T. Glover & Co., Ltd.

The directors' report for the year ending December 31st, 1903, shows that the amount standing at the credit of profit and loss account is £7,309 4s. 9d. This is arrived at as follows:—

Manufacturing profit		£32,025 9 3
Add—Dividends on investments, rents, and miscellaneous receipts		1,739 13 6
		33,765 2 9
Deduct—Management and administration expenses	£20,954 17 11	
Interest, bankers' charges, &c. ..	3,760 14 8	
		24,715 12 7
		9,049 10 2
Add—Balance from last account	4,280 10 6	
Less—Voted for directors' remuneration	200 0 0	
		4,080 10 6
		13,130 0 8
Deduct—Interest at 4½ per cent. on first mortgage debenture stock for year ending December 31st, 1903	4,250 0 0	
Interest on loans	1,570 15 11	
		5,820 15 11
		£7,309 4 9

"The surrender of ordinary shares of the company to the nominal value of £35,150 by the original vendors has been duly completed, and the reduction of capital by this amount has been approved by the Court. There has been a considerable decrease in output, due to a trade depression experienced throughout the entire industry, but material economies and improvements have been effected, resulting in a substantial reduction in standing charges. In addition to the general trade depression, many of the electrical projects so long contemplated have not as yet been put into operation, with the result that the demand for the manufactures of the company still remains low. There are indications of the prospects of the company showing an improvement during the remainder of the current year. The directors regret that the result of the working during the past year does not permit them to recommend the payment of a dividend to the preference shareholders, although the general position of the company is now more satisfactory. The anticipated demand for the non-lead-covered cable, referred to in the last report, is being realised. Two Bills relating to the Trafford Park area, promoted by the Trafford Park Estates, Ltd., and the Stretford Urban District Council, are before Parliament, and steps are being taken to protect the company's rights and easements affected thereby. To meet requirements common to the trade, the directors have from time to time found it necessary to give their personal undertakings for the fulfilment of contracts entered into by the company, some of which obligations are still existing. They recommend the formation of a fund to cover such undertakings, and a resolution will be submitted to the shareholders at this general meeting authorising this arrangement to be carried into effect. During the past year Mr. W. P. J. Fawcus and A. H. Howard have resigned their positions as directors of the company. Mr. Ll. B. Atkinson joined the board in July last, and takes an active position as an executive director of the company, managing in particular the London office, and also co-operating with Mr. E. A. Claremont in the general conduct of the business. Mr. E. A. Claremont's appointment as managing director has been confirmed, and his services retained by agreement. The whole of the directors retire, but are eligible, and offer themselves for re-election. The auditors, Messrs. Edwin Guthrie & Co., also retire, and, being eligible, offer themselves for re-election."

The sixth annual meeting was held on Wednesday, March 30th, at the company's offices, Trafford Park, Manchester, but, owing to the large representation, under the articles of association, necessary to form a quorum, no business could be transacted. The Press was not admitted, but our representative was informed that Mr. Ormerod took the chair and made some observations on the general position of the company. As there was not a quorum of shareholders, he said the meeting would stand adjourned till April 6th. Steps, the chairman added, were being taken to obviate a similar difficulty in future, by amending the articles of association so as to provide for a more reasonable quorum.

Winchester Electric Light and Power Co., Ltd.

The sixth annual general meeting was held at Winchester on March 22nd, Mr. T. F. Kirby presiding. The directors' report showed that the progress of the company during the year ended December 31st last was satisfactory, the equivalent of 7,301 8-c.p. lamps having been added, making the total connection 35,557 lamps. Including the balance brought forward from last year's accounts, £128 16s. 11d., the accounts showed a net profit of £4,784 14s., which, after payment of debenture interest, left a balance of £3,079 13s. 11d available for dividend. The directors recommended that a dividend for the half-year at the rate of 7 per cent. per annum, making 5½ per cent. for the year, be paid, and that £1,200 be placed to the reserve for the renewal of plant, leaving a balance of £156 to be carried forward. During the year 1,312 ordinary shares had been issued at par and fully paid up, and £1,900 of debentures had been issued at a premium.

After waiting half an hour for a quorum, the Chairman said the only business that could be done would be to declare a dividend and adjourn the meeting for a week. Before doing so he made a short statement. He proposed that the dividend be declared. This was carried.

The meeting was adjourned for a week as there was not a quorum present.

Thames Iron Works S.B. and Engineering Co.—The report for 1903 says that the electrical engineering department has been busy during the year, and orders have recently been secured which, with the work already in hand for the *Black Prince*, will keep the department fully engaged throughout the year. It is probable that considerable extensions of this department will shortly have to be made to meet the increasing electrical requirements of the works, and to keep pace with the orders now coming to hand.

Guildford Electricity Supply Co.—The report for 1903 says that the business continues to increase steadily, the gross receipts for the past year being £3,897, as against £3,318 for 1902. The balance of the net revenue account, after providing for payment of the dividend on the preference shares issued in lieu of the founders' shares, for depreciation, and also for payment of a further instalment of the heavy law costs incurred in 1902, is £475. Out of this balance it is proposed to pay a dividend of 3 per cent. on the ordinary shares, and to carry forward the balance of £71.

Perth Electric Tramways (W.A.) Co., Ltd.—The report for 1903 shows that the net revenue amounted to £26,300, an advance of £2,600. With the amount brought forward, the directors are able to pay the whole of the preference interest to date, place £6,000 to reserve, and carry a small balance forward. Last year, the preference interest was 12 months in arrear.

Primitiva Gas and Electric Lighting Co. of Buenos Ayres, Ltd.—The report for the year 1903 states that the balance of revenue is £115,405. After deducting interest on debentures, expenses, fees of directors and trustees, income-tax, &c., there remains a net profit of £83,823. The balance brought forward was £10,289, making a total of £94,113. The amount written off towards amortisation of the item "discount on debentures and expenses of issue" is £2,500, and the amount placed to reserve account is £15,000. The directors recommend a dividend of 5s. per share, tax free, equal to 5 per cent. for the year, on the ordinary shares, leaving £16,613 to be carried forward.

City of Buenos Ayres Tramways Co.—The directors have declared a balance dividend of 4s. per share for the six months ended December 31st last, placing £3,000 to reserve, and carrying £2,645 forward.

Stock Exchange Notices.—The Committee has been asked to appoint a special settling day in:—Consolidated Electrical Co., Ltd.—109,251 ordinary shares of £1 each, fully and partly paid, Nos. 1 to 109,251. The Committee has further been asked to allow the following securities to be quoted in the Official List:—Mather and Platt, Ltd.—Further issue of 7,495 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 32,506 to 37,600 and 87,501 to 90,000; Oxford Electric Co., Ltd.—Further issue of 2,500 ordinary shares of £5 each, fully paid, Nos. 14,311 to 16,810.

Metropolitan Electric Tramways, Ltd.—Allotment letters were on Wednesday being posted for the whole of the 350,000 4½ per cent. debenture stock of this company.

STOCKS AND SHARES.

Wednesday Evening.

While the holiday air still clings to some of the Stock Exchange departments, markets as a whole are decidedly better for their vacation. Definite prospects of cheaper money encourage investment, and speculation is being fanned by Paris and New York. The war as a European factor has grown less terrifying, and although a host of new issues are said to be on the point of appearance, the public will, it is hoped, subscribe for them more readily now that the various clouds on the financial horizon look like diminishing. This, it may be remarked, is the view of the optimist.

Speaking of new issues, we shall not be surprised to hear that the underwriters of the Metropolitan Electric Tramways Debenture have got left with about 75 per cent. of the stock for which they wrote. May be some of them are thankful that the percentage was not more. Only a nominal market exists at present for the stock. The company's Deferred shares are still about 4s. and the Preferred a little under £1.

London United Tramways have improved to 11⅛, and the Debenture stock is 102. Possibly the rumours about fresh capital requirements may have something to do with the advance, and the holiday traffic was a good one. Dublins are a little better at 13 and the Preference keep at 15½. Calcutta Trams change hands about 7, and City of Buenos Ayres about 9, while Anglo-Argentines are a harder market at 5, the round figure having been paid several times this week. The Debenture has risen 2 to 129½. Distinctly better, too, are British Electric Traction Ordinary at 9 and the Preference at 11. The former have recovered the relapse of last week upon the support being extended, of whose necessity we wrote nine days ago. This assistance has had a steadying effect, and the announcement that the next dividend payment will probably be equal to that of the corresponding period seems at last to help towards restoring confidence in the shares. British Columbia Electric Deferred is 2 better at 98½.

Electrical markets a few years ago would have been sharply shaken by the death of Mr. J. S. Forbes, but the veteran chairman and director having withdrawn from so many of his companies of late, the gap which he leaves is more personal than anything else. Of the numerous undertakings with which Mr. Forbes used to be associated, the National Telephone Co. is one of the few in which the proprietors had substantial cause for gratitude to him. He could drive a hard bargain, and he did it with the Post Office on behalf of the Telephone Co., retiring from the chairmanship soon after this feat was accomplished. The various issues of the concern are unaffected by his death. National Telephone Deferred, in fact, has risen a further 4½ points to 86, and a point advance stands to the credit of the two Debenture stocks, with the new Debenture quoted at 4 premium. The First and Second Preference shares have, however, both receded 10s., and will probably continue on the same grade. The Third Preference are ⅛ down at 5, but the Preferred stock is 3 points up at 104 middle.

Metropolitan Districts have hardened to 33⅜, although the company was once under Mr. Forbes's management, as many of the shareholders still remember. Metropolitan Consolidated is 2 per cent. harder at 87½, the stock being in short supply. Central London Ordinary gave way another point to 91½, but Citys are unchanged, and so is Waterloo and City Ordinary. Great Northern and City Preferred Ordinary continue dull at 6; Great Northern, Piccadilly & Brompton being equally firm at 9½. East London is dealt in at 4⅜, and the steam railway market has received a good deal of attention from the purchasing public since the holiday, the fine weather having proved very useful to traffic receipts. Mersey stands at 8, the result of the first half-year's working under electric traction not having affected the price of the stock.

Of the half-score of changes in the telegraph list, several are due to dividend deductions, and present no feature of interest. Direct Spanish Ordinary are quoted the same as they were before being marked *ex*, but the official price is too wide to be a real guide, and the same observations apply to Western Telegraph shares. Eastern Extensions have added ¼ at 11¼, and several of the prior charge issues are 1 per cent. up, both the Eastern and South African Debentures, for instance, London Platino-Brazilian Debentures, and Direct Spanish Debentures. Great Northern of Copenhagen, at 25½, are the fraction better, and Globe Telegraph Preference at 12½ are ¼ higher in sympathy with the better tone in this market generally. Submarine Cables Trust mark 119¾ this week. West Coast of America are $\frac{1}{16}$ lower at 2s. 6d. Henley's at 12 are really unchanged, the dividend being 9s. 6d., and British Insulated Ordinary at 5⅜ are *ex* 4s. In the Miscellaneous section Willans & Robinson are very weak at 2⅛ on the passing of the dividends, the Preference also being flat at 4, while the Debenture stock is 95. Babcock & Wilcox are 2$\frac{15}{16}$ and 1⅛ for the Ordinary and Preference respectively. Brush Ordinary, at 10s. middle, are ¼ down, but the market has been more or less nominal for some time past.

All the changes save one in the Electric Lighting list are caused by the dividends, the exception being Chelsea shares, which have risen 5s. to 6¼, and are also *ex* the dividend of 3s. 6d. Mr. J. S. Forbes was at one time on the boards of the London Electric and the Edison & Swan Companies, but had retired from both some time before his death. Metropolitans have recovered the amount of the distribution, and so have County Preference, although the Ordinary are some 6s. lower. The gilt-edged list is steady, but quiet, the rising investment demand scarcely having reached this section yet.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations March 28th.	Closing Quotations April 6th.	Business done week ended April 6th, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2¼— 8½	2½— 8½	..	..
119,700£	Do. do. 5 % Deos., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	.. — ..	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	48 — 51	48 — 51	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	91 — 93	92½	91½
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	6¾— 7½	6¾— 7½	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4¼— 5¼	4¼— 5¼	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	..	180 —190	180 —190	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	90 — 92	89 — 91 xd	91	90
16,000	Cuba Telegraph	10	4 %	6½%	..	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	15½— 16½	15½— 16½	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	..	2¾— 3½	2¾— 3½ xd	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7½— 8½	7 — 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	98 —101½	99 —102	..	..
60,710£	Direct United States Cable	20	3½%	3½%	..	10 — 10½	9¾— 10½ xd	..	..
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	117 —122	117 —122	121	118½
1,955,555	Do. 3½ % Pref. Stock	100	..	..	..	86 — 89	86 — 89	87¾	87¼
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	104 —107	104 —107	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	10½— 11½	11 — 11½	11½	11½
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	103 —106	103 —106	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	98 —101	99 —102	101	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	100 —103	..	..
180,227	Globe Telegraph and Trust	10	6½%	..	..	8 — 8½	8 — 8½	8⅜	8¼
180,042	Do. do. 6 % Pref.	10	..	..	..	12 — 12½	12 — 12½	12 1/16	12¼
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	24½— 25½	25 — 26	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	..	38 — 41	38 — 41	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	100 —103	100 —103	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	6 %	6 %	100 —102	103 —105	104	103½
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	80 — 83	85 — 87	86	80½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	12 — 14	13¾	12½
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	12 — 14	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5¼	4¾— 5⅛	5 1/16	5
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 96	95 — 97	96¼	95½
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	99 —100	99 —101	100	99½
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞— 1	⅞— 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,839	Reuter's	8	5 %	..	..	6¾— 7⅛	6¾— 7⅛	..	..
8,803	Submarine Cables Trust	Cert.	..	..	..	115 —120	115 —120	119¾	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5¾— 6	5¾— 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4¾— 5¼	4¾— 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,509	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	..	11¾— 12¼	11¾— 12¼	12⅛	..
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	99½	..
88,321	West India and Panama Telegraph	10	..	..	..	⅜— ½	⅜— ½	..	..
84,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	5¾— 6¼	5¾— 6¼	6 1/16	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½— 5½	4½— 5½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

30,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4 — 5	4 — 5	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	89 — 94	89 — 94	..	..
100,000	British Electric Traction	10	9 %	8 %	..	8 — 9	8¾— 9⅜	9⅜	8¼
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	9½— 10½	10¾— 11¼	11	10 1/16
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	119 —122	116 —119 xd	117¼	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	8 %	6 — 6¼	5¾— 6¼ xd	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¼— 5¾	5¼— 5¾	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	⅜— ½	⅜— ½	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	..	½— 1	½— ¾	¾	⅝
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	¾— 1¼	¾— 1¼	27/32	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	96 — 99	96 — 99	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	72 — 77	72 — 77	..	..
35,000	Callender's Cable Construction shares	5	20 %	15 %	..	10½— 11½	10½— 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½— 5¾	5¼— 5¾	5½	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	91 — 94	90 — 93	92	..
494,098	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	98 —101	98 —101	..	..
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	85 — 88	85 — 88	..	..
1,330,000	City and South London Railway	Stock	2 %	2½%	2⅝%	49 — 52	49 — 52	51	50½
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	5 %	..	1⅝— 2	1¾— 2	1⅞	1⅝
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	96 — 99	96 — 99	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	Nil	Nil	..	½— 1¼	½— 1¼	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % 2n Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1¼— 1⅞	1¼— 1⅞	1⅞	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2½— 3	2½— 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9 — 9½	9 — 9½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	94 — 99	93 — 98 xd	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	15 %	12 — 13	11½ — 12⅝ xd	..	..
200,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5¼	5 — 5¼	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18 — 19	18 — 19	..	..
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	99 —102 xd	99 —102 xd	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅜— 4⅝	4⅜— 4⅝	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	9¼— 10¼	9¼— 10¼	..	..
87,350	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	33 — 36	33 — 36	34½	33½
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3⅛%	3⅛%	88 — 91	88 — 91	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (continued).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME,	Stock or Share.	Dividends for the last three years 1901.	1902.	1903.	Closing Quotations March 28th.	Closing Quotations April 6th.	Business done week ended April 6, 1904. Highest	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	†	..	..	..	5/8 — 3/4	5/8 — 3/4	..	..
50,000	Do. 7 % Pref.	1	..	..	..	1 1/8 — 1 1/4	1 1/8 — 1 1/4 xd	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	115 — 118	113 — 116 xd	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	10 %	10 1/4 — 11	10 1/2 — 10 3/4 xd	10 11/12	10 1/2
20,000	Do. do. 7 % Cum. Pref.	5	..	..	..	9 3/4 — 10 1/4	9 3/4 — 10 1/4 xd	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	..	..	..	106 — 109	106 — 109	..	..
60,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	8 %	7 — 7 1/4	7 — 7 1/4	7 3/8	7 7/16
70,000	Do. do. 4½% Cum. Pref. ..	5	..	..	..	5 1/4 — 5 3/8	5 1/4 — 5 3/8	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4 3/4 — 5	4 3/4 — 5	..	..
40,000	Do. do. 1903	5	..	..	..	4 3/4 — 5	4 3/4 — 5	4 7/8	4 3/4
350,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	101 —103	102 —104	103	103 1/2
44,486	*Chelsea Electricity Supply, Ord.	5	4 %	4½%	5½%	5 3/8 — 6 1/4	6 — 6 1/4 xd	6 1/4	6 1/8
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	5 %	5 %	5 %	10 1/4 — 10 3/4	10 1/4 — 10 3/4	10 7/16	10 3/16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14	13 — 14	13 3/8	13 1/8
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid ..	..	..	..	..	121 —126	121 —126	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	7 1/2 — 8 1/4	7 — 8 xd	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11 — 12	11 — 12	..	..
400,000‡	Do. do. 4½% Deb. Stock	..	..	..	..	106 —109	106 —109	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	5 1/2 — 6 1/4	5 1/2 — 6 1/4	6	..
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	5 1/2 — 6 1/4	5 1/2 — 6 1/4	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	103 —106	103 —106	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	10 %	12%	11 — 12	11 — 12	11 3/8	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	103 —106	101 —104 xd	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1 — 1 1/2	1 — 1 1/2	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	4 1/2 — 5	4 1/2 — 5	5 1/16	5 1/4
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	94 — 97	95 — 98	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6½%	7½%	8½%	18 — 19	18 — 19 xd	18 1/2	18
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	5 1/8 — 5 3/8	5 1/4 — 5 3/8 xd	5 7/16	5 1/4
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	95 — 98	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
50,000	Do. do. 4 % First Mort. Debs.	100	..	..	..	99 —102	99 —102 xd	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	97 —100	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3 — 3½	3 — 3½	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	12½	8 %	3 — 3½	3 — 3½	3 3/8	3 1/8
30,000	Urban Electric Supply, Ord.	5	..	..	..	4 3/4 — 5	4 3/4 — 5 xd	..	..
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4 7/8 — 5 1/4	4 7/8 — 5 1/4 xd	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	12 %	13½%	12 1/2 — 13 1/2	12 1/2 — 13 1/2	12 3/4	12 3/8
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6 1/2	6 — 6 1/2	6 1/16	..

* Subject to Founders Shares. † Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, April 6th.

CHEMICALS, &c.

		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric .. .. .. per cwt.		5/-	..
a ,, Nitric .. .. per cwt.		22/-	..
a ,, Oxalic .. .. per cwt.		82/-	..
a ,, Sulphuric .. .. .. per cwt.		5/6	..
a Ammoniac, Sal .. .. .. per cwt.		42/-	..
a Ammonia, Muriate (crystal) .. per ton		£38 10	..
a ,, ,, ... per ton		£30	..
a Bleaching powder .. .. .. per ton		£4 10	..
a Bisulphide of Carbon .. .. per ton		£15	..
a Borax .. .. per ton		£18	..
a Benzole (90 %) .. .. .. per gal.		7/-	..
a ,, (50/90 %) .. .. .. per gal.		5/6	..
a Copper Sulphate .. .. .. per ton		£18	..
a Lead, Nitrate .. .. .. per ton		£24	..
a ,, White Sugar .. .. per ton		£31	..
a ,, Peroxide .. .. .. per ton		£27 10	..
a Methylated Spirit .. .. .. per gal.		2/6	..
a Naphtha, Solvent (90% a 160° C). per gal.		5/6	..
a Potash, Bichromate, in casks .. per lb.		8d.	..
a ,, Caustic (75/80%) .. per ton		£24	..
a ,, Bisulphate .. .. per ton		£35	..
a Shellac .. .. per cwt.		208/-	8/- inc.
a Sulphate of Magnesia .. .. per ton		£4 10	..
a Sulphur, Sublimed Flowers .. per ton		£6 10	..
a Recovered .. .. per ton		£5 10	..
a ,, Lump .. .. .. per ton		£5	..
a Soda, Caustic (white 70 %) .. per ton		£10 15	..
a Crystals .. .. .. per ton		£3	..
a Bichromate, casks .. .. per lb.		2½d.	..

METALS, &c.

b Aluminium Ingots, in ton lots .. per ton		£180	..
b ,, Wire, in ton lots .. per ton		£168	..
b ,, Sheet, in ton lots .. per ton		£166	..
p Babbitt's metal ingots .. .. per ton		£43 to £180	..
c Brass (rolled metal 2" to 12") basis per lb.		6¾d.	..
c ,, Tube (brazed) .. .. per lb.		8¾d.	..
c ,, ,, (solid drawn) .. .. per lb.		7¾d.	..
c ,, Wire, basis .. .. .. per lb.		7d.	..
c Copper Tubes (brazed) .. .. per lb.		9¼d.	..
c ,, ,, (solid drawn) .. per lb.		9¾d.	..
g Copper Bars (best selected .. per ton		£72	..

METALS, &c. (continued).

g Copper Sheet .. .. .. per ton		£72	..
g ,, Rod .. .. .. per ton		£72	..
c ,, (Electrolytic) Bars .. per ton		£64	£2 inc.
c ,, ,, Sheets .. per ton		£80	£2 inc.
c ,, ,, Rod .. per ton		£74	..
c ,, ,, H.C. Wire per lb.		8d.	¼d. inc.
f Ebonite Rod .. .. .. per lb.		3/3	..
f ,, Sheet .. .. .. per lb.		8/-	..
n German Silver Wire .. .. per lb.		1/6	..
h Gutta-percha fine .. .. .. per lb.		8/-	..
h India-rubber, Para fine .. .. per lb.		4/7½ to 4/8	dec.
i Iron, Charcoal Sheets .. .. per ton		£18	..
i ,, Pig (Cleveland warrants) per ton		44/9	1/- inc.
i ,, Forgings, according to size per ton		From £11	..
i ,, Scrap, heavy .. .. per ton		47/6 to 50/-	..
i ,, Wire, galvanised No. 8 .. per ton		£9 15	..
g Lead, English Ingot .. .. per ton		£12 10 to £12 12 6	..
g ,, ,, Sheet .. .. per ton		£18	..
m Manganin Wire No. 28 .. .. per lb.		8/-	..
g Mercury .. .. per bot.		£8 5	..
d Mica (in original cases) small .. per lb.		6d. to 1/9	inc.
d ,, ,, ,, medium per lb.		2/6 to 4/-	inc.
d ,, ,, ,, large .. per lb.		4/6 to 8/6	inc.
p Phosphor Bronze, plain castings .. per lb.		1/- to 1/2½	..
p ,, rolled bars & rods per lb.		1/- to 1/3	..
p ,, ,, strip & sheet per lb.		From 1/1	..
o Platinum .. .. per oz.		£4	..
p Silicium Bronze Wire .. .. per lb.		9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n per ton		£68	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block .. .. per ton		£129 to £130	..
g ,, Foil .. .. .. per lb.		1/6	..
n ,, Wire, Nos. 1 to 16 .. .. per lb.		1/7	..
p White Anti-friction Metals— "White Ant" brand .. per ton		£42 to £62	..
j Yarns, 2/10s Grey Cotton, on sp'ls per lb.		8d.	..
j ,, 6 lea. Flax .. .. per lb.		5½d.	..
j ,, 3 ply 10 lbs. Russian .. per lb.		4 7/12d.	..
j ,, 10 lbs. Russian, single .. per lb.		4½d.	..
j ,, 180 lbs. Jute rove .. per ton		£11	..
k Zinc, Sh't (Vieille Montagne bnd.) per ton		£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

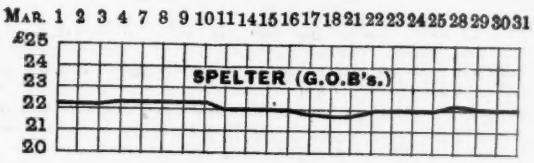
Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Apr. 2	1,167	+295	44	52,872	+10,685	10	—
Birmingham ..	,, 2	5,205	+158	14	71,229	+ 3,136	8½	—
Bournemouth ..	Mar. 23	907	+ 15	51	51,431	—	10½	—
Blackburn	Apr. 1	1,007	+ 270	1	1,007	+ 290	13½	—
Blackpool	Mar. 31	344	— 42	52	41,727	— 425	8½	—
,, —Fleetw'd	Apr. 2	439	+171	14	2,773	+ 85	7½	—
,, —Lytham	Mar. 31	165	—	22	3,286	+ 579	7½	—
Bolton	,, 27	1,618	— 68	52	93,216	+ 8,799	25	—
Bradford	,, 31	1,938	+141	52	194,810	+25,267	47	—
Brighton	Apr. 3	938	+ 163	—	46,089	—	7½	—
Bristol	,, 1	4,607	+167	—	—	—	28	—
Devonport ..	Mar. 25	487	+ 26	12	5,413	+ 776	5	—
Dudley—Sto'rb'ge	,, 25	767	— 18	12	8,758	+ 895	18½	—
Gateshead ..	,, 25	858	+ 20	12	10,301	+ 599	10½	+ ½
Gr'n'k—Pt. Glsgw	,, 25	481	— 7	12	5,548	+ 616	7½	—
Hartlepool ..	,, 25	243	+ 14	12	2,924	+ 308	6½	+2
Oldham—Ashton	,, 25	488	— 67	12	5.825	— 374	8	—
Potteries	,, 25	1,697	— 7	12	19,662	+ 1,420	28½	—
Southport	,, 25	237	— 17	12	2,811	+ 225	5½	—
South Staffs. ..	,, 25	745	— 82	12	9,786	+ 832	21½	— ½
Swansea	,, 25	450	— 17	12	5,481	+ 146	5½	—
Wolverhampton ..	,, 25	857	— 27	12	9,959	— 177	10½	+8
Yorks. Wool Dist.	,, 25	564	+337	12	6,035	+ 2,170	6	—
Miscellaneous ..	,, 25	2,042	—	12	22,369	—	—	—
Burnley	Apr. 2	1,333	+437	—	—	—	10½	+3½
Burton-on-Trent ..	,, 3	339	—	35	11,737	—	8½	—
Cardiff	Mar. 26	1,815	+127	—	100,458	+23,428	1	—
Chatham & District	,, 24	489	+ 20	12	5,926	+ 1,085	9½	—
ork	,, 31	898	— 19	13	5,009	— 130	9	—

* Compared with the corresponding period of 1903.

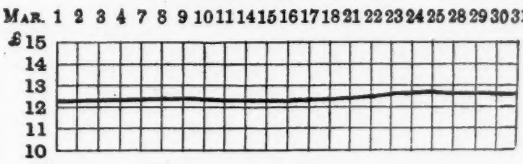
Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Dover	Mar. 26	168	— 15	12	2,080	— 183	3	—
Dublin	Apr. 1	4,181	—193	14	56,258	+ 456	47	+ ½
East Ham	,, 2	718	+162	—	34,312	+ 8,971	5	+ ½
Glasgow	,, 2	13,412	+288	44	596,648	+56,049	69½	+5
Halifax (2 weeks) ..	Mar. 23	2,457	+274	51	66,349	+ 6,479	33	+2½
Huddersfield ..	Apr. 2	1,197	+ 18	—	—	—	—	—
Hull	,, 2	2,144	+360	53	101,662	+ 8,991	13	+2
Ilkeston	Mar. 30	133	—	—	—	—	3½	—
Ipswich	Apr. 2	434	—	—	5,899	—	9	—
Isle of Thanet ..	,, 2	432	+115	13	3,153	— 242	10½	—
Leeds	Mar. 26	5,086	+ 89	—	279,330	+15,521	41	—
Liverpool	,, 26	10,016	— 98	13	123,188	+ 2,975	103	—
London C. C. ..	,, 19	10,644	+1897	49½	498,363	+86,61[illegible]	39½	—
Manchester	,, 26	10,913	+2197	—	594,903	+292,371	72	—
Newcastle	Apr. 2	3,611	+ 489	—	—	—	17	—
Portsmouth	Mar. 26	1,362	— 79	—	87,526	+ 5,216	14½	—
Salford	,, 28	3,687	+646	—	196,803	+ 52,761	30	—
Sheffield	,, 28	4,366	+111	52	234,241	+20,206	32½	+4½
Southampton	,, 24	842	— 48	—	—	—	25½	—
Southend-on-Sea ..	,, 30	211	— 3	52	15,643	+ 2,247	6	—
Sunderland	,, 27	1,101	+ 39	52	61,840	+ 3,014	20	+8
Tynemide	,, 28	300	+ 33	12	3,308	+ 564	8·9	+·48
West Ham	,, 31	263	—	5	1,306	—	1½	—
Wolverhampton ..	,, 27	464	+ 49	—	—	—	6½	—
Cen. London Rly. ..	Apr. 2	6,297	—825	14	98,122	+ 159	6	—
City & S. Lon. Rly.	,, 3	2,712	—362	14	44,118	— 220	6½	—
Dublin—Lucan Rly.	,, 3	101	+ 7	14	1,268	+ 84	6½	—
L'pool Overh'd Rly.	,, 3	1,547	— 56	14	21,337	+ 258	6½	—
Mersey Railway ..	Mar. 26	1,452	+249	12	17,152	+ 4,252	4½	—

METAL MARKET.

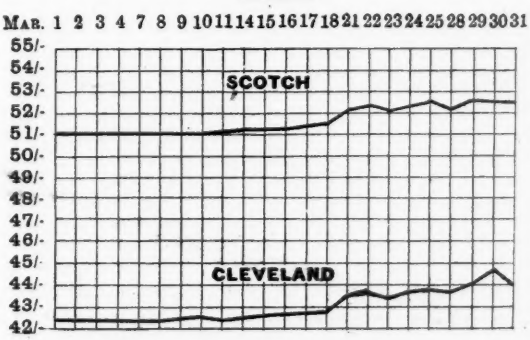
Fluctuations in March.



LEAD (ENGLISH).



IRON.



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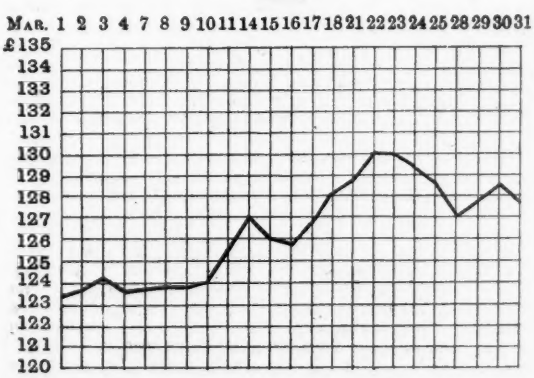

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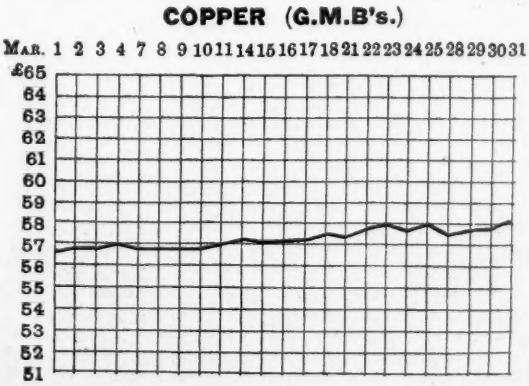


INSTITUTION OF ELECTRICAL ENGINEERS.

LOCALISATION OF FAULTS ON LOW-TENSION NETWORKS.

By W. E. Groves, Associate Member.

(*Paper read at Birmingham, March 16th*, 1904.)

It is perhaps fortunate that, in contrast with some other public supplies, that of electricity requires for its successful operation that faults and leakages be immediately remedied. Any laxity in maintaining the insulation is sooner or later fraught with disaster. It is also fortunate that such leakages or faults can be readily detected, and that their location and elimination is a comparatively simple matter. The remarks which follow refer particularly to a three-wire low-tension network, with the neutral earthed at the generating station, or sub-station, through a resistance of 2 ohms.

The rapidity and ease with which a fault can be localised depends in a great measure on the arrangement of the networks, and still more on the completeness of the plans and details kept.

The more closely a network is "netted," the more troublesome it is to localise faults, and from this point of view it is very desirable that each feeder should have its own defined network, and be only linked to other similar networks where necessary for balancing and equalising purposes. All possible points of junction between the networks of the various feeders should be labelled on the mains plans, and distinguished in the boxes by some particular type of fitting.

There have been various opinions expressed as to the degree of fusing of networks that should be resorted to. In the writer's opinion it is desirable, in addition to the feeder fuses in the station, to fuse at all points where it is found advisable to effect a junction between the networks supplied by different feeders, and generally *at these points only*.

The obvious danger of connecting two or more feeders through a distributor without fusing is that in the event of a short circuit, or bad fault, the faulty feeder fuse in the station may blow, and the "short" be fed through a small distributor of sufficient resistance to prevent another heavy feeder fuse from blowing immediately, but carrying enough current to badly overheat and destroy it.

The fuses at the inter-connecting points can be comparatively light, because if the system is properly arranged, the balancing currents will be small.

During summer it is usually no disadvantage to work with many of the linking points open, which provides an excellent opportunity for overhauling the various networks. When a link is closed it should be noted in a book, or on a card provided for the purpose in the office, in order that there may be no delay or hesitation if it is necessary to sever the various feeder networks for localising a fault.

Although the convenience of independent feeding for fault-localising is very great, the efficiency and balance of the system must be the first consideration, and the fuse links inserted wherever any advantage can be obtained by inter-connection.

Fusing of the linking points gives no cause for anxiety, as there is little chance of the fuses blowing except when they are fulfilling their proper functions, and if they should be severed from any other cause nothing worse can occur than a temporary want of balance. The neutrals, at points where fuses are inserted on the outers, will of course be connected up solid. By the use of inter-changeable blocks it is possible to fuse any line which may become an object of suspicion.

A junction box, with interchangeable blocks of three types, is described in Appendix I.

As the space for fusing in a junction box is necessarily limited, unless the box be of cumbrous dimensions, it is perhaps possible that in aggravated cases the fuse arc might spread; but even if this did occur, it would be a small matter, and it would "save the situation," for if you can start an arc, the sudden drop in volts due to the "short" would break the arc, and the faulty line would be freed.

It is conceivable that more extinctions would result from the blowing of distributor fuses on slight provocation, than from the very rare blowing of a feeder fuse. If the faulty feeder is automatically isolated by means of link fuses, it should not be difficult to locate and disconnect the "shorted" line, an intimate knowledge of the network by means of plans and details being of the first importance. It is a simple matter to draw the various connecting bolts, and try with portable switch and fuse when the line is clear. A means of connecting this switch should be provided in the junction boxes.

The subject of short circuits is so closely related to the question of distributor fuses, and the lay-out of the system generally, that "shorts" occupy first attention, but the maintenance of the insulation in such a manner as to protect the system from faults that may develop into "shorts" is of the greatest importance. On the soundness of the insulation depends the "safety" of the consumer and the reliability of supply. In the discussion of Mr. A. M. Taylor's recent paper, "Network Tests and Station Earthing," reference was made to various tests. The desire to make this paper as complete as possible must be the excuse for the repetition of remarks made on that occasion.

The tests and trials the writer has found convenient are as follows:—

(*a*) Observance of reading of recording ammeter permanently connecting the neutral to earth through a low resistance.

(*b*) Joint insulation test by "Russell's method."

(*c*) Checking polarity of fault by observance of feeder ammeter when "flashed."

(*d*) Detection of faulty feeder by "flashing."
(*e*) Partial localision by means of "transferring."
(*f*) Localision by disconnection to shortest length.
(*g*) Final localision by induction method.

The avoidance of interruption of supply in any degree is of great consideration, and these tests and trials are selected with that object in view.

Fig. 1 shows an arrangement of panels for the ready performance of tests (*a*) to (*e*) inclusive. The somewhat elaborate array of neutral

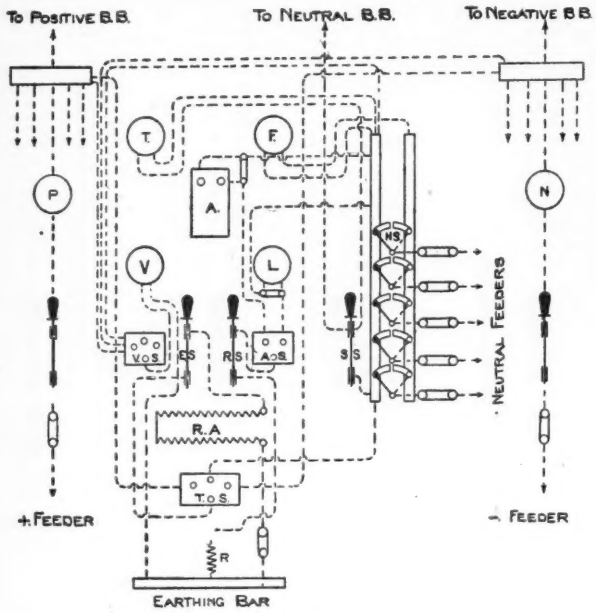


Fig. 1.

switches is necessary to avoid the inadvertent disconnection of a neutral cable when testing.

The connections of the panels will be easily traced, and where necessary the functions of the various instruments are described in what follows:—

(*a*) *Recording Ammeter.* The reading and recording of this instrument is so far useful that it shows any alteration in the state of the insulation of the mains, and if the reading is considerable, renders test (*b*) necessary. Its great weakness lies, as has been many times pointed out, in its readings being differential, and not less in the fact that it may be shunted by a neutral fault. These qualities render it wholly unreliable as an indicator of the state of the insulation of the mains. It is sometimes most useful in showing the nature of a fault (such as a defective motor armature by oscillations of the needle), also the records frequently indicate, by the time of the arrival and disappearance of a fault, whether or not it is controlled by a consumer's switch.

If the recording ammeter is reading zero it indicates one of three conditions: (1) that the insulation is absolutely sound; (2) the outers are equally unsound; or (3) the instrument is shunted by a neutral fault. The first case is an imaginary one—in stations of any size; the second of very infrequent occurrence, and the last always to be suspected.

(*b*) *Russell's Test.*—This is most convenient for a rapid and frequent test. The formula (*vide* Mr. Russell's communication, *Journal*, Vol. 30, p. 326), is $\text{F} = \frac{\text{V}_2 - \text{V}_2'}{c} = \frac{\text{V}_2}{c} - \text{R}$.

Referring to fig. 1, R is the resistance in series with the recording ammeter A (say 2 ohms), so that the test resolves itself into the reading of C on the ammeter L in series with or substituted for A at the time of testing, and a momentary opening of the switch R S to read V_2 on the voltmeter V. For moderately high resistances the value of R may be ignored. V should theoretically be of infinite resistance, *i.e.*, electrostatic, but the results of this test are quite sufficiently accurate if any high-resistance voltmeter is taken.

The writer is experimenting with a combined instrument which, if satisfactory, would replace V and L on the panel fig. 1.

The object of this instrument is to read F directly on an ohm scale when R S is momentarily opened. A diagram and description of the suggested arrangement is given in Appendix III.

If the recording ammeter fails to notify any leakage, and the test (*b*) indicates that the insulation is "down," it is fairly safe to assume that the neutral is at fault, although occasionally a balance may occur. Under these conditions V_2 will be small and R S may be left open while the rough tests (*c*) and (*d*) are made. The opening of the switch R S avoids heavy local currents through R and bad sparking at the switches.

(*c*) *Checking Polarity of Fault by "Flashing"*—A central zero ammeter T is provided, which can be cut in to take the total neutral current by opening the switch S S. Watching this instrument until a fairly steady deflection is shown, either of the outers may be connected to earth through the adjustable resistance R A by means of the switches T S and E S. If the neutral is faulty a "kick" will occur on T when E S is closed. It is sometimes necessary to make this trial when most of the motors on circuit are shut down on account of the unsteadiness of the deflection on T. In the case of a balanced fault the neutral ammeter T will be unaffected by this trial, the switch R S being open, and the faulty feeder will be indicated by "kicking" of one of the ammeters P, N, on the opposite side to that earthed.

(*d*) *Detection of Faulty Feeder.*—If the last test has proved that the neutral is unsound, an ammeter F may be cut into each feeder separately by means of the switch N S, and the last test repeated until the faulty feeder is detected.

If considerable fault is shown on A, the switch R S may be momentarily broken while close observation is made of the instruments P and N. Obviously, a heavy balanced leak is in the nature of a short-circuit, and being beyond the control of R, makes itself sufficiently apparent on P and N. In extreme cases of this kind it may be necessary to cut out the faulty pole of one feeder while the fault on the other pole is being eliminated; but if the insulation generally is kept under close observation, this double fault should be of very rare occurrence.

(*e*) *Partial Localision by Transference.*—It is usually the case that a junction can be made between the distributors branching from the various feeders (preferably through fuses, as mentioned above). By transferring the distributors from one feeder to another, and momentarily earthing one of the outer wires, if the neutral is faulty, and flashing the switch R S if an outer is "down," the fault may be very readily localised, to the shortest length the arrangement of the network will permit. So far consumers have in no way been interfered with unless operations may have blown the fuse of a faulty internal circuit.

The earthing of either pole through an adjustable resistance R A by means of the switches T S and E S is of great service in blowing out faults controlled by small-circuit fuses on consumers' premises. It may occur that the neutral is "held down" by a fault which may

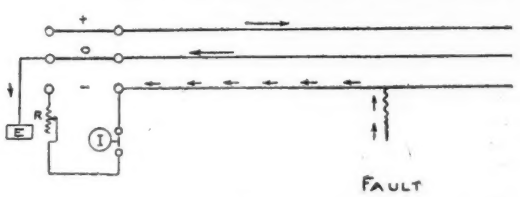


Fig. 2.

disappear on a very slight earthing of one of the outers. The consumer will have the fuse replaced, and it may be necessary to repeat the process until he thinks it worth while to investigate the cause of his trouble. It is probable that in this case a few lamps on the faulty circuit will be burnt up; it is the penalty of having a fault.

Of course if, in addition to the above-mentioned fault, a considerable fault on either outer develops, it will automatically affect this process; but should such a fault be absent a defective single-light circuit may spoil the insulation records for days. There would be little satisfaction in finding, after a tedious search, a fault controlled by a five-ampere fuse. The writer is assuming that there are no neutral fuses in the purely three-wire circuits, or that they are sufficiently heavy to be unaffected by such slight earthing as has been mentioned.

(*f*) *Localision by Disconnection.*—If disconnection can be resorted to without inconvenience to consumers, it may save the time and trouble of carrying test (*e*) to its extreme limits, the transfer method meaning frequent journeys to the station to study the feeder ammeter or time in fixing up instruments at the feeding points. If arrangements can be made for disconnection, tests may be made by means of lamps or instruments. If the fault be on either outer, the volts between neutral and earth will be raised. Having connected up the lamp or voltmeter between neutral and earth at the nearest network box, the various lines or services are disconnected until the voltage drops. When the fault is neutral (the earthing switch R S at the station being open), an earth connection may be made through a switch and fuse at the junction box where the test is being carried out, the switch being opened after each disconnec-

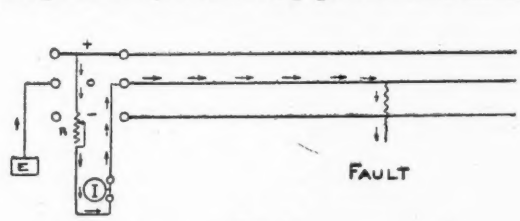


Fig. 3.

tion until the faulty line is detected by a rise of volts on an instrument connected between neutral and earth, when the faulty line is cut off.

As an alternative to the last trial, a lamp may be connected between either live outer and the faulty neutral, the latter and other outer being disconnected. The faulty line being at or near earth potential, the lamp will glow until the fault is made dead. It is well to make trials at the station before carrying out these rough street tests, in order that the results may be correctly interpreted.

(*g*) *Final Localision by Induction Method.*—The tests described above having failed to indicate the exact position of the fault, final

localision may be made by means of an interrupter and induction coil.

This generally well-known method consists in putting an alternating or interrupted current through the faulty cable, the circuit being completed through earth. A coil in circuit with which is a telephone receiver is taken over the route of the faulty cable, starting from the point from which the testing current is supplied.

In a successful test the receiver beats steadily until the point of the fault is reached, when the beat dies away more or less suddenly, owing to the test current going to ground.

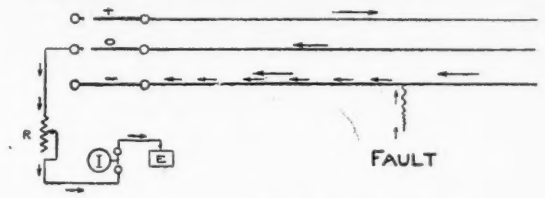


Fig. 4.

A description of an interrupter designed by the writer, and also of a convenient form of coil, will be found in Appendix II.

Figs. 2 to 6 represent various methods of connecting the interrupter. The small arrows indicate the interrupted earth current, large arrows the supply current, and double-headed arrows the fault current.

Fig. 2 represents the simplest case where the faulty line can be disconnected, and the interrupter inserted in series with the fault, the fault being on one of the outers.

Fig. 3 shows a method of localising a fault in a neutral. The faulty neutral and one outer are disconnected, and the interrupter connected between the "live" outer and the faulty line.

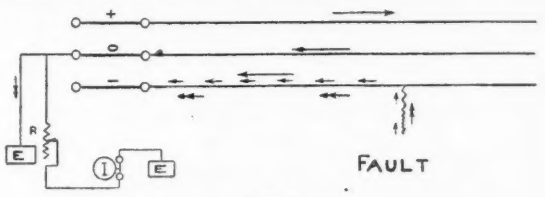


Fig. 5.

In fig. 4 the neutral is not "permanently" earthed, or the fault is so bad that the removal of the "permanent" earth connection has no appreciable effect on the pressure between neutral and earth. No interruption of supply is necessary in this case, the pulsating current being superimposed on the supply current.

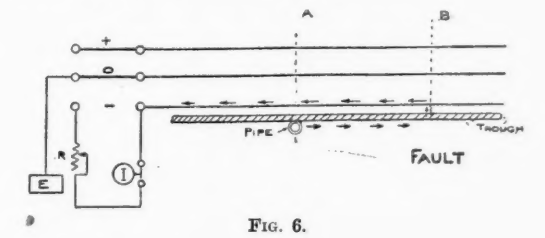


Fig. 6.

If the coupling is as shown in fig. 5, no interruption of supply is necessitated, the pulsating current being superimposed on both the supply and the fault current.

When iron ducts are in use or the cables are metal-covered, contact between the ducts or armour and a gas or other metal pipe sometimes leads to false indications, particularly if the surrounding soil be dry.

The effect is shown in fig. 6. The fault being at B (*i.e.*, the contact between conductor and metal cover), the current takes the lowest resistance path to earth at the point of contact with the pipe returning upon itself. In this case the telephone will cease beating at A, the effect of the pulsating current between that point and B being neutralised. The ground is opened at A and the pipe contact removed when, unless there are other similar contacts, a true indication is given. Proximity, but not actual contact, has the same effect in a less degree.

The coil is therefore useful in indicating where the cable ducts and other pipes are too close together, but proper precautions should be taken to avoid such contiguity when the cables are laid.

(*To be concluded.*)

NOTES ON THE STEAM TURBINE.

By the Hon. C. L. Parsons, A.M.I.C.E., A.M.I.E.E.

In the course of a few notes on the Parsons turbine, before the Newcastle Local Section, on the 21st ult, the author remarked that in the cylinder no lubrication is required, since no parts are touching; the two end packing glands being of similar construction to the balancing pistons, also run clear, hence no oil can possibly find its way into the exhaust. Turbines are running in breweries and chemical works, where the exhaust is led straight into the vats or liquids which require to be heated, and at Heaton part of the turbine exhaust steam is specially condensed to be used as distilled water for delicate chemical processes. The cost of oil for a large turbine works out at about ·002d. per kilowatt-hour.

Among the earlier machines were the 350-kw. alternators put down at the Manchester Square station of the Metropolitan Electric Supply Co., of London, in place of the reciprocating engines, which had been causing immense annoyance through vibration. These turbines gave complete satisfaction, and several of them have since been converted to continuous current. Since then the size of turbines has gradually increased, units of 500 kw. being put down in Newcastle, Scarborough, Cambridge, London and other places.

The next important advance was made in 1900, when two alternators, each of 1,250 kw. capacity, were constructed for the city of Elberfeld, in Germany. The turbines had two cylinders arranged in tandem, and ran at 1,500 revolutions per minute. They were coupled to four-pole alternators with revolving armatures, giving single-phase current at 4,000 volts and 50 periods. The air-pumps were driven off the turbine shaft by worm and worm-wheel, the circulating pumps being separately driven. The steam consumption at full load with slight superheat was 18·8 lbs. per kilowatt-hour, or 11·9 lbs. per indicated horse-power hour. The parallel running was very good, the turbines steadying the 1,000-kw. Sulzer-Brown-Boveri alternators running at 93 revolutions per minute.

The single-cylinder type of turbine has again been adopted for the larger as well as for the smaller sizes, being found cheaper as well as more efficient, besides requiring a shorter engine room. Plants up to 10,000 i.h.p. are now being constructed with a single cylinder. As a high vacuum is most important for obtaining the best results in steam economy, ample space is allowed at the end of the turbine for the exhaust steam, and the condenser is generally placed in a pit straight under the turbine so that the drop in vacuum may be as small as possible between the machine and the condenser, while the length of piping required is greatly reduced. The following table shows the effect of variation of vacuum on the consumption of steam in the case of a 1,500-kw. set. For smaller sizes the variation is not so marked.

Vacuum (bar = 30 in.) In.	Difference in steam consumption per 1 in. of vacuum. Per cent.
29	6
28	5
27	4
25	3½
24	3
22	2½
16	2

As regards the cost of obtaining these high vacua, a little investigation will show that the extra power required to maintain a higher vacuum in a given condenser (and the cooling surface need not be larger than usual) is very small in comparison with the saving of steam in the main turbine with a good vacuum. A high vacuum is of no advantage in the case of a reciprocating engine, for various reasons. The low-pressure cylinder would require to be very large to deal with the comparatively enormous volume of steam, resulting in much greater cost, friction and condensation. The exhaust passages and ports would also present many difficulties, and make the whole plant very bulky and clumsy, and in no way more efficient.

One of the most interesting examples of what can be done with steam turbines is the Forth Banks station of the Newcastle and District Electric Light Co., Ltd. It was first started in 1889, four units of 75 kw. each being put down; it now contains a total of 3,000 kw., installed in a very small space, the only disadvantage of the station being the heavy cost of carting away the ashes. The demand for direct current has increased so fast that a new station has been built in the Close. Two units of 1,000 kw. each have been started during the last few months, and a third of 1,500 kw. has just been ordered. The 1,500-kw. set will embody further improvements. The governor will be of the mechanical type, keeping the speed constant within 2 per cent. The dynamos, each of 750 kw., will be of a new design, specially wound to give fixed commutation from no load to 50 per cent., or even 100 per cent. overload. If found desirable at a subsequent date, this set can be over-compounded for traction purposes.

Among other large continuous current plants made recently are two 1,800-kw. tandem sets at 480 volts, for Manchester Corporation, running at about 1,000 revolutions per minute. When tested on site, the steam consumption was about 19¾ lbs. per kilowatt-hour at full load and 23 at half-load without superheat, with 120 lbs. steam pressure. Three sets of 300 kw. each have just been completed for the Corporation of Derby. They run at 3,900 revolutions per minute, and are intended to supply current for traction and lighting. The dynamos are specially wound to give sparkless commutation for all changes of load without movement of the brushes. Curves were taken on a Horn tachograph showing the variation of speed when the main circuit was made and broken on a load of 350 kw.; the temporary variation did not exceed 4½ per cent., and the permanent 2½ per cent. The dynamo was tested by throwing 350 kw. off and on when running both as a shunt machine and as a compound, no movement being found necessary for the brushes, which were of brass wire. The following table shows the variation of voltage under different conditions.

	kw.	Voltage.	Speed.
Compounding in use	0	505	3,075
" "	336	565	3,000
Shunt only	300	500	3,000
	0	543	3,075
	0	520	3,000
(Constant excitation)	0	518	3,000

Many large alternators have been constructed during the last few years, including two of 750 KW. capacity erected at Bristol last autumn. The latter are of the revolving-armature type, running at 1,860 r.p.m.; they have six poles and generate single-phase current at 2,000 volts and 93 periods. A certain number of two-phase alternators have been constructed, including four of 500 KW. capacity for the Metropolitan Electric Supply Co., at 1,000 volts and 60 periods, and two of 1,500 KW. capacity for the Corporation of Sheffield at 2,000 volts and 50 periods, all of the revolving-armature type.

Three-phase sets are more numerous, especially for voltages of about 6,000. At present plants varying in size from 750 KW. to 3,500 KW. are being constructed, the large sets being for the Carville station of the Newcastle Electric Supply Co., all of the revolving-field type, the number of poles being either two or four. The stators are built up in a cast-iron case with ample provision for ventilation through the core, the windings being placed in tubes of tape and pressspahn, which, on the whole, are the most satisfactory. Each tube is tested thoroughly electrically by flashing before being put into the stator, but it should be pointed out that an excessive pressure test, though it may not appear to cause damage, is really injurious just in the same way as a boiler is permanently strained by being tested too highly. The rotors have former-wound coils with plenty of insulation and special supports to resist the centrifugal strains due to the high speed. The pole-tips can be removed and a damaged coil replaced by the spare one in a few hours.

A plant of 1,500 KW. capacity is now being constructed for the Ultimo power station of the Sydney tramways, N.S.W. The periodicity is 25, requiring a two-pole rotor running at 1,500 revolutions per minute. For colliery work three-phase alternators with revolving armatures generating at a pressure of 440 to 550 volts are becoming very numerous, the largest of this type being a 750-KW. set for Ashington Colliery. The output of the steam-turbine in England has increased enormously during the last two or three years, and includes plants of large size for most of the large towns and power companies. On the Continent, Messrs. Brown-Boveri have some large plants in hand, including three-phase alternators of 10,000 H.P. for Messrs. Krupp's works at Essen and five of 8,000 H.P. for the Paris Metropolitan Railway, while in America the turbine has become very popular, and threatens to displace the reciprocating engine in all the larger schemes.

THE DESIGN AND CONSTRUCTION OF BUILDINGS CONNECTED WITH THE GENERATION AND SUPPLY OF ELECTRICITY.

In a paper read by Mr. C. S. Peach before the Royal Institute of British Architects, at the Institution, 9, Conduit Street, the author emphasised the need for an architect to study the buildings required for modern scientific industries. The buildings connected with the generation and supply of electricity are a conspicuous example of such structures. In less than twenty years they have developed from small commonplace sheds to complex structures frequently of great size, occupying prominent sites, and supplying power for innumerable purposes. Upwards of 750 of these buildings have in about fifteen years been erected in the United Kingdom alone, and a much greater number abroad.

Primarily central stations may be divided into three classes—viz:—

1. The power station—the class now coming into vogue and the real central station—at which power is generated and transmitted to sub-stations for distribution.

2. The sub-station, which receives the power from the central source, and retails or distributes it to consumers in its immediate vicinity.

3. Direct supply stations where the power is both generated and distributed.

The author treated at considerable length the building requirements, equipment, and arrangements of the various classes of power stations, describing more or less fully the principal stations in the United Kingdom, on the Continent, and in America. Working drawings and views of the buildings were shown by lantern slides, and a large number were displayed on the walls of the meeting-room.

A great number of water-power stations have been erected abroad, but there are none of first-class importance in Great Britain.

At Niagara, probably the best-known water-power station, the volume of water is estimated to represent 7,000,000 H.P., the greater part of which can, and eventually will, be made available. The machines dealing with this power will be concentrated in a comparatively small area. This concentration of enormous power within a building is a new feature. The structure must be calculated with an ample margin of safety, and to allow considerable strength above what would be considered sufficient in ordinary practice.

The steam-power station is a comparatively recent introduction, and the author predicted a great demand for these in the future. The station of the London Electric Supply Corporation at Deptford was, perhaps, the first of this kind, designed by Mr. Ferranti in 1888. Stations erected ten years later in America have followed very closely Mr. Ferranti's design. The Americans have displayed great ingenuity in installing very powerful plant on sites of small superficial area; stations with plant on more than one floor are more common there than elsewhere. A remarkable instance is the Edison station at Philadelphia, where the plant is installed in an eleven-story building, each department being placed on a different floor, one above the other.

The Manhattan station, New York, is typical of central stations generally in one respect. It is built on a bad foundation, the gneiss bed rock bottom being deeply eroded by streams which formerly traversed it. It is therefore of unequal supporting power, which accounts for the apparently unequal strength and thickness of the foundations. Large quantities of water are used in connection with the work carried on in central stations, therefore they are frequently erected on the banks of rivers and canals, where the sub-soil is hardly suitable for such buildings and careful adjustment of the weight is necessary. Sometimes the subsoil is hard in places and yielding in others. In such cases foundations like those of Manhattan have been found suitable, but in very soft soils much waterlogged, it is, as a rule, better to support the load on concrete floats proportionate to the weight, allowing somewhat more than half the load which would be taken for an ordinary building. A thick float of concrete all over the site is a common method of meeting the difficulty, both in English and German practice. It is a good plan on clay, but should be keyed on the underside on looser soils.

Referring to the architectural treatment of some of the Continental stations, it is often said of buildings treated like Geneva, Munich, and the Berlin stations that they are expensive. They are generally less costly than many buildings which look plain and are so described. The difference is that in the one case full value is obtained from the embellishments by good design, in the other case the same or greater expense is incurred for material not essential to construction frittered over the surface, and therefore ineffective.

Almost every combination and kind of plant and design of central station is to be found in Great Britain. One of the largest power houses in London will eventually be that of the Central Electric Supply Co. at Grove Road, St. John's Wood, which will supply power for general purposes for the west-end districts of London served by the Westminster Electric Supply Corporation and the St. James's and Pall Mall Electric Lighting Co. It is situated on the bank of the Regent's Canal, the site being 7½ acres in extent, all of which will eventually be covered with the buildings. Upwards of 150,000 H.P. can be placed on the site if the plant is arranged on the one-floor system. One-half of the first section has recently been completed, and provides accommodation for 14,800 H.P.

The author gave details also of the power stations at Edinburgh, Glasgow, Manchester, Sunderland, Brighton, Eastbourne, Liverpool, Dublin, Chiswick, the City of London Power station near Blackfriars Bridge, and others.

Of the composite type of direct supply stations in small towns, sooner or later combination between towns and districts will take place, and co-operative power stations will replace this class, and those then existing will become partly sub-stations.

In regard to sub-stations, every precaution should be taken to prevent transmission of mechanical vibration or escape of sound beyond the building. The buildings must be dry, well ventilated, and well lighted in every part.

The author gave some interesting illustrations of the chimney-shafts of central power stations. They may be erected in groups of from two up to six or more, and should be of better construction and appearance than is often deemed sufficient. Cast-iron caps are frequently objected to as being heavy; properly designed, they are lighter than a corresponding mass of brickwork. Within reasonable limits a fairly heavy cap is an advantage and not a disadvantage.

The author concluded by remarking on the intimacy which must exist between the engineer and architect during the carrying out of this class of work.

Prof. Kennedy opened the discussion, and expressed his satisfaction that architects were seriously taking the matter up, because these large stations had to come, and the more attractive the outside appearance could be made the better for all concerned. The question of vibration was a serious one, although it must be confessed that in this matter the architect was largely at the mercy of the engineer, who must have foundations of a particular shape. Experience had shown that the foundation should be made as broad as possible to prevent rocking; non-combustible materials should also be used in these buildings.

Mr. John Slater called attention to the fact that there were earth vibrations and air vibrations.

Mr. Ferranti and Mr. Gay also took part in the discussion.

DESIGN OF SMALL DYNAMOS.

By J. W. BURLEIGH.

The writer is of opinion that the design of small dynamos has not received the attention of technical journals, &c., which it justly deserves. Formulæ for various details of machines have, from time to time, appeared, but it very rarely happens that a certain specific output is chosen, and the principal calculations for the sizes of electrical details are shown in a concise form.

For the manufacturer to be enabled to produce machines at either 110, 220 or 440 volts, with equal facility, and in equal time, it is of the greatest importance that the carcass, before winding, should be the same, that is, of course, when it has a certain definite kilowatt output assigned to it. By

careful design it is not a very difficult matter to be able to use the same core discs for the three voltages, and even the same number and size of slots. It usually happens, however, that in windings for 110 volts, we can use half the number of sections in the commutator that are required for the two higher voltages. This system of using the same parts, and only varying the windings to suit each voltage, must necessarily greatly reduce stock parts; although at times in a line of machines some slight sacrifice is made by adhering to this method, it is more than counter-balanced by the many advantages obtained. For the manufacture of machines on these lines, the writer is convinced that the bipolar type of dynamo or motor is preferable up to about 10 KW.

To illustrate the course which I adopt in small machines I have selected an output of 2·4 KW. at a mean speed of 1,200 r.p.m. I purpose giving briefly the principal formulæ used in determining the results which will follow.

All dimensions, except where otherwise stated, are in inches, and Kapp lines are used.

We first determine the specific output (W_s); this will be taken as watts per revolution; from this figure we can easily get good approximate dimensions of the principal sizes in the armature—

$$D^2 \times L = W_s \times C.$$

D = diameter of armature.
L = length of armature.
W_s = watts per revolution.
C = a constant.

For machines with a specific output of from 1·5 to 5, C may be taken at 110.

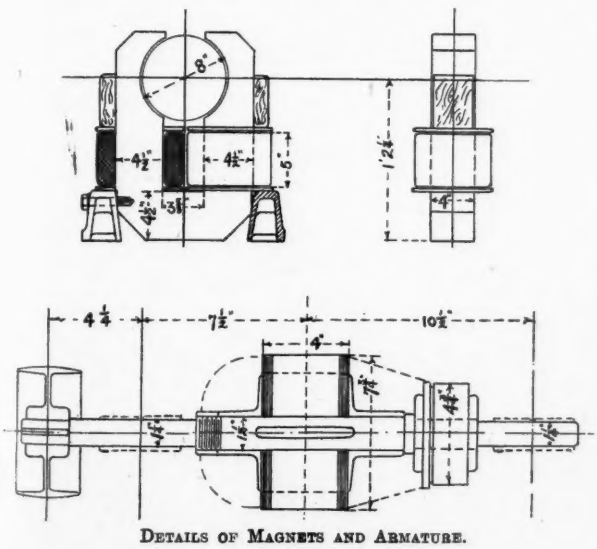
D can at once be settled by taking a certain peripheral speed; this usually is from 2,500 to 3,000 ft. per minute in small armatures.

Therefore, $D = \frac{P_s}{\text{revs.}} \times \frac{12}{\pi}$.

P_s = peripheral speed.

It follows from above, $L = \frac{W_s \times C}{D^2}$.

The next step is to find a suitable flux through armature (za). Some years ago I went into the question of determining the za, and, from experience with a large number of



Details of Magnets and Armature.

machines, I found, for the best results and economical production, that this quantity varied as the square root of the specific output, × 140—

$$za = \sqrt{W_s} \times 140.$$

It will be apparent that, by using the same number of slots for three different voltages, the za will necessarily vary for one or other of the voltages.

Having determined the za, the number of conductors =

$$Nc = \frac{V}{\text{revs.} \times za} \times 10^6.$$

To obtain sparkless collection, I find that $\frac{\text{gap amp.-turns}}{\text{cross amp.-turns}}$ should not be less than 1·1, and if the reactance volts are over 4 this quantity should be at least 1·3.

The reactance volts are calculated on the lines laid down by Mr. Hobart in his recent paper; I use the formula in the following form :—

$$I = \frac{(E \times 20 \times T_s^2 \times S_s) + (F \times 2 \times T_s^2 \times S_s)}{10^8}$$

I = inductance in henrys.
E = embedded length of conductor in inches.
T_s = turns per section.
S_s = maximum number of sections short-circuited.
F = free length of conductor in inches.
$= \frac{D' \pi R_s}{2 W}$
= Frequency of commutation.
R_s = Revolutions per second.
W = Width of brush.
Reactance volts = $2 \pi I f C'$.
C′ = current in each conductor.

Hysteresis in armature core
$(Da \times 930)^{1·6} \times ·003 \times$ periodicity $\times$ v $\times 10^{-7}$.
Da = lines per square inch armature.
v = volume of core in cubic centimetres.

Hysteresis in teeth
$(Dt \times 930)^{1·} \times ·003 \times$ periodicity $\times$ v $\times 10^{-7}$
Dt = Lines per square inch at bottom of teeth.

As far as I am aware no satisfactory formula has been evolved for accurately predetermining the eddy current losses. From the tests of a large number of small machines, I find that 80 per cent. of the total hysteresis loss gives a good approximation for the watts lost by eddy currents.

The temperature rise is calculated on the assumption that 1 watt lost per sq. in. corresponds to a rise of 50° F. On this basis the temperature rise of the 110-volt machine which follows would be $50 \times \frac{1·07}{1} = 54°$ F., 1·07 being the watt loss per sq. in.

	1.	2.	3
Volts	110	220	440
Amperes	22	11	5·5
Speed	1,200	1,100	1,300
Watts per revolution	2 02	2 2	1·86
Diameter of armature	7¾ in.	7¾ in.	7¾ in.
Length of armature	4 in.	4 in.	4 in.
Effective length	3·6 in.	3·6 in.	3 6 in.
Number of slots...	48	48	48
Size of slot	·265 in. × ·75 in.	·265 in. × ·75 in.	·265 in. × ·75 in.
Dia. of armature bottom of slot	6½ in.	6½ in.	6½ in.
Width tooth at bottom ...	·141	·144	·144
Polar angle	125°	125°	125°
No. of teeth under pole + 10 per cent. for spread	18·25	18·25	18·25
Section of armature	16·65 sq. in.	16 65 sq. in.	16 65 sq. in.
Area teeth at bottom	9 5 sq in.	9·5 sq. in.	9·5 sq. in.
Area of gap actual	35 sq. in.	35 sq. in.	35 sq. in.
Effective area 90 per cent. of actual area	31·5 sq in.	31 5 sq. in.	31·5 sq. in.
Area of field magnets	18 sq. in.	18 sq. in.	18 sq in.
Bore of magnets	8 in.	8 in.	8 in.
Number of conductors	480	1,152	1,728
Number of commutator sections	48	96	96
Turns per section	5	6	9
Size of wire	14 S.W.G.	17 S.W.G.	19 S.W.G.
Mean length of turn	32 in.	32 in.	32 in.
Resistance of armature at 120° F.	·29ω	1·43ω	4·18ω
Volts lost in armature winding	7	17	25
Volts lost due to brush contact and connections (approximate)	2	4	6
Total internal volts	119	241	471
Flux full load	206	190	210
Flux constant	145	128	154
Leakage coefficient	1·3	1·3	1·3
Average length (assumed) of lines in magnets	28 in.	28 in.	28 in.
Lines per sq. in. armature ...	13·38	11·4	12 62
„ „ teeth	21·7	20·0	22·1
„ „ gap	6·55	6 04	6·67
„ „ magnets ...	14 9	13·75	15 15
Amp.-turns armature	120	110	130
„ teeth	350	300	400
„ gap	3,030	2,840	3,140
„ magnets	1,430	1,140	1,680
Back turns (assumed)	300	300	300
Total a/s required	5,280	4,690	5,650

Length of coil	5 in.	5 in.	5 in.
Inside length of turn	18·5 in.	18·5 in.	18·5in.
Gauge of wire	21 S.W.G.	24 S.W.G.	26 S.W.G.
Depth of winding	1 in.	1·25 in.	1¼ in.
Mean length of turn	21·6 in.	22·5 in.	23·5 in.
Number of layers	22	35	50
Turns per layer...	109	139	167
Total turns on both coils ...	4 796	9,730	16,700
Yards	2 890	6,090	10,800
Resistance cold...	86·5ω	390ω	1,040ω
„ warm	99ω	456ω	1,200ω
Shunt current	1·11 amp.	·483 amp.	·366 amp.
Ampere-turns	5,320	4,700	6,100
Watts lost in both coils ...	123	106	161
Radiating surface of coil ...	248 sq. in.	255 sq. in.	280 sq. in.
Temperature rise F.	50°	42°	58°
Weight of wire...	27 lbs.	26·5 lbs.	32 lbs.
Sparking Factors.			
Gap-turns per pole	1,540	1,420	1,570
Cross a/s per pole	966	1,160	885
Gap ampere-turns / Cross ampere-turns	1·59	1·22	1·7
Total a/s on armature	2,800	3,320	2,550
Total a/s on coils / Total a/s on armature	1·89	1·41	2·21
Diameter of commutator ...	4¾ in.	4¾ in.	4¾ in.
Bar and insulation	·311	·155	·155
Width of brush	½ in.	½ in.	½ in.
Turns short-circuited	2	4	4
Frequency of commutation ...	298	274	324
"Embedded" length	7·2 in.	7·2 in.	7·2 in.
"Free" length	24·8 in.	24·8 in.	24·8 in.
Inductance in henrys	·000097	·00028	·000628
Current in each conductor ...	11·6	5·75	3
Reactance volts...	2·11	2·78	3·8
Hysteresis and Eddy Current Loss.			
$(Da \times 930)^{1·6} \times ·003$	9,400	8,400	9,800
Periodicity	20	18·4	21·7
Volume in cubic centimetres (below teeth)...	1,700	1,700	1,700
Watts lost	32	27	36
$(Dt \times 930)^{1·6} \times ·003$ ...	23,000	20,300	24,000
Volume of teeth cubic centimetres...	364	364	364
Watts loss	17	14	19
Total hysteresis loss	49	41	55
Eddy current loss ·8 hysteresis loss	40	33	44
Total core loss ...	89	74	99
Ohmic Loss in Armature.			
Total armature current ...	23·2	11·5	5·9
Watts lost	156	189	146
Total watts lost in armature ...	245	263	245
Radiating surface	230 sq. in.	230 sq. in.	230 sq. in.
Watts per sq. in.	1·07	1·14	1·07

NEW PATENTS APPLIED FOR, 1904.

ompiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

11,823A, 1903. "Improvements relating to electric telegraphy." A. Muirhead. March 23rd. (Date applied for under Patents Rule 9, May 23rd, 1903.)

27,044, 1903. "Improvements in secondary or storage batteries." C. G. M. Hardingham. (The Electric Boat Co., United States.) March 26th. (Date applied for under Patents Rule 9, December 10th, 1903.) (Complete.)

6,780. "An improved life-guard for electric and other tramcars." H. G. Harrison. March 21st.

6,811. "Improvements in electrical signalling instruments." H. W. Sullivan. March 21st.

6,832. "Improvements in and relating to electrolytical extraction of metals from solutions." J. F. Webb. March 21st.

6,833. "Improvements in electro-mechanical cut-outs." J. E. Spagnoletti. March 21st.

6,834. "Improved means for automatically controlling the passage of electric currents." J. E. Spagnoletti. March 21st.

6,843. "A new or improved terminal attachment for the conducting wires of electrical machines and apparatus." A. Sauser. March 21st. (Complete.)

6,857. "Improvements in electrical switching apparatus." J. R. Dick. March 21st.

6,873. "Improvements in and relating to 'clusters' for incandescent electric lamps." J. H. Dale. March 22nd. (Complete.)

6,878. "Improvements in electrical ignition apparatus." A. Eckstein and H. J. Coates. March 22nd.

6,889. "Electrical distribution." J. L. Woodbridge. March 22nd.

6,896. "Improvements in and relating to electric tramways and railways." F. W. Baynes. March 22nd.

6,943. "Improvements in and relating to safety fuses." C. Koch. March 22nd. (Complete.)

6,959. "Improvements in filaments and in methods of manufacturing the same." H. C. Levis. (The General Electric Co., United States.) March 22nd.

6,960. "Improvements in filaments and in methods of manufacturing the same." H. C. Levis. (The General Electric Co., United States.) March 22nd.

6,961. "Improvements in and relating to electric motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) March 22nd.

6,972. "Improvements in electrodes for arc lights." F. J. Gerard and L. Fiedler. March 22nd.

7,017. "Improvements in reflectors for electric glow lamps." J. T. Connell. March 23rd.

7,044. "Improvements in and relating to electro-capillary apparatus." J. T. Armstrong and A. Orling. March 23rd.

7,052. "Improvements in supports or carriers for the glass globes of electric arc lamps." W. W. Adams. March 23rd.

7,056. "Improvements in or relating to the production of metals of the alkali group by electrolysis." E. A. Ashcroft. March 23rd.

7,061. "Improvements in electro-depositing apparatus." The Leeds Copper Works, Ltd., and J. C. Jobling. March 23rd.

7,064 "A symmetrical vapour conducting-medium for alternating currents." O. Holz. (Date applied for under Patents Act, 1901, March 23rd, 1903, being date of application in United States.) March 23rd. (Complete.)

7,065. "Transmitting alternating currents through a vapour." E. Weintraub. (Date applied for under Patents Act, 1901, March 23rd, 1903, being date of application in United States.) March 23rd. (Complete.)

7,066. "Alternating current rectifying apparatus." C. P. Steinmetz. (Date applied for under Patents Act, 1901, March 23rd, 1902, being date of application in United States.) March 23rd. (Complete.)

7,067. "Rectifying alternating currents." E. Weintraub. (Date applied for under Patents Act, 1901, March 23rd, 1903, being date of application in United States.) March 23rd. (Complete.)

7,073. "Primary battery." W. R. Burrows and T. Lyons. March 24th.

7,118. "Electrical emergency railway brake." C. Mackintosh. March 24th.

7,129. "Improvements in and relating to telegraphic signal systems." C. G. Burke. March 24th. (Complete.)

7,197. "Improvements relating to electric bells." E. G. Harcourt. March 25th.

7,208. "Improvements in controlling systems for electric motors. G. Westinghouse and L. M. Aspinall. (Date applied for under Patents Act, 1901, May 1st, 1903, being date of application in United States.) March 25th. (Complete.)

7,209. "Improvements in multi-voltage electric generators." G. H. Gibson (Date applied for under Patents Act, 1901, April 4th, 1903, being date of application in United States.) March 25th. (Complete.)

7,211. "Improvements in and relating to apparatus for the control of electrical switches and like devices." L. Robinson & Co., Ltd., and E. Garside. March 25th.

7,217. "Improvements in magneto-electric machines." F. R. Simms. March 25th.

7,238. "Improvements in electric insulators." J. G. Lorrain. (Societa Ceramica Richard-Ginori, Italy.) March 25th. (Complete.)

7,247. "Improvements in and relating to the scaling of electrical conductors." L. R. Lee. March 26th.

7,249. "Improvements in and relating to electrical fuse-boxes, junction boxes, and the like." L. R. Lee. March 26th.

7,267. "Improvements in electrical switches." V. Bornand. March 26th.

7,293. "An improved sparking plug." The Albany Manufacturing Co. Ltd., and F. Lamplough. March 26th.

7,298. "Improvements in arc lamp electrodes." R. Fleming. (Date applied for under Patents Act, 1901, March 26th, 1903, being date of application in United States.) March 26th. (Complete.)

7,299. "Improvements in arc light electrodes and method of making same." J. T. H. Dempster. (Date applied for under Patents Act, 1901, March 26th, 1903, being date of application in United States.) March 26th. (Complete.)

7,304. "Method of and apparatus for administering 'cold light' electric baths." G. E. Gaiffe. March 26th.

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Electrical Switches. S. H. Heywood and H. W. Heywood. 3,825. February 18th.

Safety Electric Fuses. E. Mies. 3,988. February 19th.

Automatically Operated Electric Block-signalling or Brake-operating Device for Railways. N. Dobrzanski and J. Husckak. 4,089. February 20th.

Reversing Mechanism for Dynamo-electric Machinery. H. Leitner and R. N. Lucas. 4,732. February 28th.

Electrolytic Cells. W. Thomson. 4,783. March 2nd.

Electric Rheostats. E. A. Carolan. (The General Electric Co., United States.) 5,169. March 5th.

Conduits or Casings for Electric Conductors. R. H. W. Knight and L. Nagel. 5,340. March 6th.

Controlling Electric Motors. E. A. Carolan. (The General Electric Co. United States.) 5,287. March 6th.

Determining the Power Factor of Alternating Current Electric Circuits. E. A. Carolan. (The General Electric Co., United States.) 5,288. March 6th.

Electric Gas Lighters. A. J. Boult. (Electric Contact Co., United States.) 5,480. March 9th.

Electric Arc Lamps. J. J. Rathbone and E. R. Smith. 5,572. March 10th.

Electrodes for Storage Batteries. H. F. Joel. 5,845. March 13th.

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Electric Alternating Current Generator especially for Purposes of Ignition in Explosion Motors. A. Herz. 6,316. March 18th.

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Holder for Electric Light Shades. H. Simmonds. 7,286. March 28th.

Dynamo-electric Machines. W. E. Evans. (Allgemeine Elektricitats Gesellschaft, Germany.) 7,384. March 30th.

Electricity Meters Provided with Means for Registering the Maximum Consumption. W. E. Evans. (Allgemeine Elektricitats Gesellschaft, Germany.) 7,385. March 30th.

Electric Arc Lamp. A. Bureau. 7,842. April 4th.

Electric Couplings. J. N. Dauncey. 7,955. April 6th.

Space or Wireless Telegraphy. W. P. Thompson. (J. S. Stone, United States.) 8,507. April 14th.

Space Telegraphy. W. P. Thompson. (J. S. Stone, United States.) 8,508. April 14th.

Wireless Telegraphy. W. P. Thompson. (J. S. Stone, United States.) 8,509. April 14th.